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Action and Reaction of Dynamo-electric Machines.

We regret that the limited space at our command will not permit us to give a complete report of Mr. C. M. Mailloux's interesting lecture on the above subject, before the New York Electrical Society, on Friday, Feb. 23. Mr. Mailloux has for many years devoted his attention to electric lighting, making the dynamo-electric machine a special study, and that he is qualified to discuss such an intricate question, the articles on electric lighting contributed to our columns amply prove. In fact, many portions of his lecture embodied new and interesting additions to our knowledge conconcerning dynamo-electric machines, and as such possess undoubted value.

Mr. Mailloux first traced the relation of scientific knowledge to invention, and showed that progress in the one is

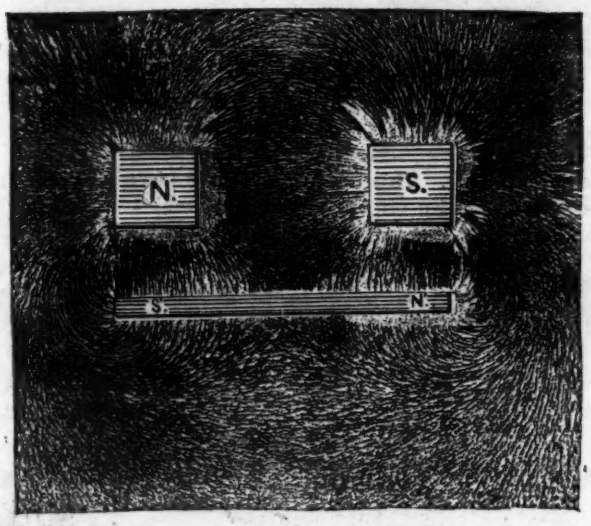

FIG. 1.

a measure of the progress in the other. Great inventions are the landmarks of principles, and perfection in any art advances hand in hand with the accumulation of our knowledge of principles.

The scientist establishes principles; the inventor applies them. The dynamo-electric machine is a striking instance of the mutual relations between science and invention; with each advance in the knowledge of its fundamental principle a new and improved type of the dynamo-electric machine came into existence. The same thing goes on to-day—we study the dynamo-electric machine precisely as the physiologist does the human system, and note every action and reaction taking place, to learn the very essence of its functions, and to find wherein we may improve on the useful results obtained. The perfection to which the dynamo-electric machine has attained is truly remarkable, if we bear in mind the very brief period of its "adolescence," which scarcely extends over five years.

Will perfection end here? Most certainly not. Competition between the various systems will make the question of greater perfection and improvement the all-important one; in point of fact, we have only begun to see the necessity of a closer study of the dynamo-electric machine. We have always been content to make our dynamos by the "cut-and-try" method; but now we must make them by the scientific method, because we do not wish to trust to chances in seeking for better results, and it is for this reason that every scrap of information gathered here and there on the subject is of great value.

There is much that we already know about the actions and reactions in dynamo-electric machines, but there is yet more of which our knowledge is very vague and insufficient, from the fact that there is here involved the phenomenon of "*action at distance*," the most absorbing and at the same time the most perplexing question in the whole domain of physics.

From the days of Descartes and Newton to the present time the whole world's wisdom of thought and of research has been concentrated on this question, and yet it cannot be said to have been answered satisfactorily. Here is a dynamo-electric machine; it consists of an armature revolving within a cylindrical space between two magnetic poles. This armature does not touch these poles, but revolves clear from them, and yet it behaves as if some great mechanical power were at work on it and opposing its motion. If there were a material communication through which pressure or leverage of any kind could be exerted, then we might understand the action taking place; but imagine a lever whose fulcrum rests upon nothing! It is almost inconceivable to the human mind. This action at a distance in the dynamo involves many a phase, and indeed many a mystery, with which we are yet laboring in our efforts to analyse the actions and reactions to which it gives rise.

The object of the lecture, the lecturer said, was to call attention to some new properties of lines of magnetic force and to show their value in interpreting these actions and reactions. Lines of force are the machinery—the levers by means of which magnetic systems act at a distance, and exert attractive or repulsive influence.

After describing the properties of lines of force, as observed by Faraday, Mr. Mailloux proceeds to describe the property of *resiliency*, which, he said, he believed he was the first to observe. He had noticed that lines of force could be bent from their course by the motion of a piece of iron in a magnetic field, but that this displacement has a limit, depending on the tension of the lines of force. By means of a ring made of elastic wire, he illustrated the rise of tension in the different portions of a line of force with varying degrees of distortion, and stated that just as the elasticity of this wire resisted distortion in any direction, and tended to assert itself and to resume its original equilibrium, so the lines of force constantly exhibit a tendency to return to their natural position in the magnetic field.

He had noticed that when a line of force was distorted or bent out of its course too far, it instantly sraightened back as quick as a flash. The first man to observe the phenomenon was a Mr. Gary, of Boston, whose experiment was considered by him a proof of a neutral line in front of the poles of a magnet. The world was made familiar with this experiment, and it had attracted the attention of the whole scientific world, from the fact that the phenomenon had never been truly accounted for.

It was while experimenting on this phenomenon, in the latter part of 1878, that the lecturer had first noticed the property of resiliency in lines of force. He was the first one to give a true theory of this action. He performed the experiment for the audience; a little iron screw was placed on an iron armature held at a short distance from the poles of a horse shoe magnet, and it remained suspended by the induced power of the armature; on moving the armature nearer the poles, the screw dropped, at a certain point, as if the armature had suddenly lost its polarity, but the screw being replaced it would still remain suspended, though a slight return motion would cause it to drop instantly.

The lecturer then proceeded to show, by means of diagrams and black-board illustrations, the distribution of the lines of force in both cases. These lines were so different in distribution from what our conception of the magnetic field of the ordinary horseshoe magnet, that he thought many would feel like doubting its accuracy; it was rather fanciful and queer. But yet it was the real condition, because he had on the table some magnetic spectra made with iron filings, that looked exactly like these diagrams as anybody could see.

Fig. 1 represents one of these spectra, the poles of the magnets being supposed to face the observer; and the armature being placed at a slight distance from each pole. It is seen that the character of the distribution is strangely altered, as may be seen by comparison with the lines of force above the poles where they are unaffected.

Their most remarkable peculiarity is that they are bent inward to fall into the armature at each end, the radius of curvature being strikingly short.

Fig. 2 shows the same magnetic field after the armature has come into contact. It is seen at once that the distribution of the lines of force is more nearly normal; it is evident also, that the lines of force must have straightened themselves at some period of the transition between the spot indicated in Fig. 1 and this. This straightening or resiliency of lines of force does not happen simultaneously in all of them, but it takes place in each individually, as it comes to the point where the controlling power of the iron is exceeded by the tension of the lines of force. Thus in the Gary experiment, he had found that with several small screws placed side by side along the whole length of the armature, they dropped one by one, beginning from the centre and working toward the ends.

The lecturer then showed several modifications of these experiments, with special reference to explaining how similar actions take place in dynamo-electric machines. He gave an interesting explanation of the manner in which lines of force are cut in polar armatures, taking the simplest form, Pixii's, as an example. The lecturer then passed on to "Ring" armatures, which he considered of much more importance, from the fact of their greater use in the modern dynamo. There had been some question among physicists as to the exact theory of such armatures. The field was divided, some believing one thing and others believing another. Some maintained that there were only two kinds of induction in the Gramme ring; others saw three or more. Among the scientists who have given this subject their attention was the Count du Moncel, the learned editor of *La Lumière Electrique*, who had advanced a theory of induced currents of a new kind, which he called currents of "interversions of polarity." The diagrams of M. Du Moncel's article were reproduced and his theory was criticised at considerable length. The lecturer showed how this kind of induction really took place by a translation of the lines of force from side to side of the magnetic field, illustrating his descriptions with several magnetic spectra. These magnetic spectra showed that M. du Moncel had not the true notion of the action and reaction which takes place in such a magnetic field, for his diagram of the distribution of lines of force in an induced bar in front of a magnetic pole was not at all accurate; it had evidently been drawn from theory, while these shown here had been drawn by the magnet itself. It was then shown that with a magnetic ring revolving concentrically on a centre between two magnetic poles, (Fig. 3) no translation of the lines of force can take place, and that, consequently, the induction of currents by in-

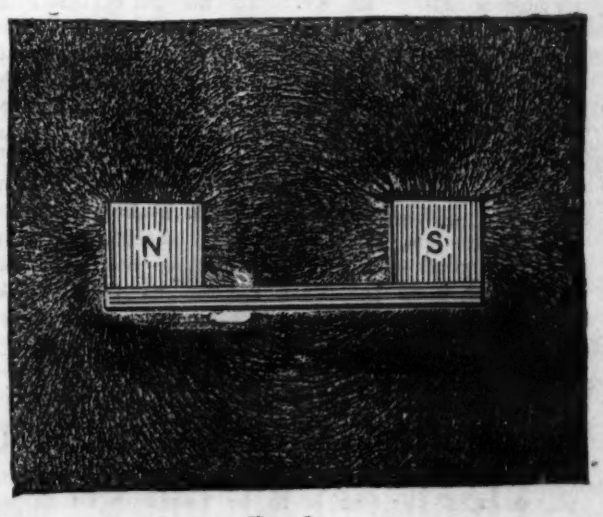

FIG. 2.

terversions of polarity in such an armature was not a reality; it was only a misapprehension that had led to that theory.

The next point shown was how the magnetic effect produced on the ring by the current reacts on the magnetic field and bends the lines of force out of their course. (Fig. 4.) Every time a section of the armature is short-circuited at the commutator these lines of force tend to straighten themselves, and in so doing they react on the wire of the armature, giving rise to local currents. The advantages of massive magnets were here shown by a reference to M. Marcel Deprez's "characteristic" curves. Reference was also made to the form and shape of the armature and to the circumstances which tend to the best results. The lecturer then reviewed the actions and reactions which occur in the field magnets. He pointed out by means of

diagrams the disadvantages of field magnets of the Siemens type, where the armature revolves in a plane at right angles to the width of the field magnets, and showed how the rapid periodical rebound of the lines of force in the neighborhood of the armature could produce oscillations in the whole system of lines of force that emerge from the magnets at a distance from the armature, and that inductive reactions take place. Such machines show greater disturbances in their field circuits because the length of wire acted upon is greater upon in greater when constructed on the shunt principle, specially if the margins of the pole-pieces were tapered to a sharp angle, as is the common practice. The induction which takes place by the reaction of the field magnet cores upon the wire surrounding it is a very important item. In most all cases it is a great detriment, because it only impedes the current by opposing actions, and makes it fluctuate. He illustrated this by an interesting experiment. A small motor was included in a battery circuit, with a solenoid of many turns. Self-induction took place in the solenoid at every change of commutation, with each wave of current, and this undoubtedly interfered with the motor, which would probably revolve faster if the same wire were placed in a straight line so as to exert no reaction on itself. Now, on introducing a bar of iron inside the solenoid, the number of lines of force oscillating with each wave of current was greater, and the reaction on the general current became more marked, as shown by the motor, whose speed decreased nearly one-half. The method of studying such oscillations in lines of force in the magnetic fields of dynamo-electric machines, first used by the lecturer, was also exhibited. A small coil of fine wire was placed at a distance of a few inches from the solenoid, while connected with a Bell telephone by means of flexible conductors. Every oscillation makes itself perceptible at the telephone as a noise. When this coil is held in the plane of the lines of force, little or no effect is produced at the telephone, but when it is held at a right angle to their course the sounds are quite loud, their intensity being greater the nearer the coil is placed to the source of action.

Mr Mailloux then passed on to the consideration of the various means of preventing the self-induction in field magnet circuits, and he described fully Mr. Keith's dyna-

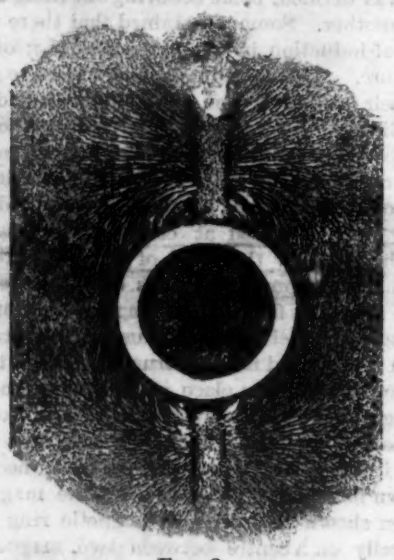

FIG. 3.

mo, which possesses features of interest in this relation. As we hope soon to publish a complete account of this interesting machine we will pass these details by. As a phase of the reactions which take place in field magnet circuits, attention was called to the curious phenomenon observed with the Griscom motor. It was noticed by Mr. Griscom that if the current passes through the armature only, and motion is imparted to it by the current, this motion increases very much the moment the field circuit is short-circuited. Many theories have been evoked to explain this phenomenon, the most generally accepted one being that the polar ends of the armature act inductively on the wire of the field magnet as they revolve past, and that this induced current magnetizes the field magnets. In the Griscom motor the field is condensed and circular, the wire being placed very favorably for such an action; nevertheless it is found that this is not necessary. The phenomenon will take place with a magnetic field of any shape whatever, which disproves the above theory. According to Mr. Mailloux, the true explanation of the fact is to be found in Lenz's law, and the reactions may be considered as being "Lenz effects." The armature, being strongly magnetic, of course magnetizes the field magnet; now while the field circuit is open this magnetism falls as soon as the polarity changes in the armature; but, on the contrary, if this circuit be closed, then the magnetism does not disappear. The moment the lines begin to collapse they cut the coils around the magnetic cores and produce a current tending to oppose this collapse or demagnetization, and to make it remain as it is; at every turn of the armature it magnetizes these cores a little more, and, as the magnetism thus falls more slowly than it is made to rise, the effect is the same as if the magnet were permanently magnetized. In Mr. Keith's machine this fact was clearly demonstrated. At every alternate quarter of a revolution, the field magnet circuit is short-circuited on itself by an automatic contrivance at the commutator. It is found that not only the magnetism of the field increases rather slowly at starting, but that it also diminishes slowly at stopping. At starting, during the rise of magnetic intensity, the Lenz effects are such as to oppose the rise; while during the fall they oppose it equally. If we take any electro-magnet and place a rapidly rotating commutator that will short-circuit it for a portion of each revolution we will observe the same phenomenon.

In conclusion, Mr. Mailloux referred to the dynamo-electric machine of the future, and said that much remained to be done before it became perfect. He quite agreed with Prof. Sylvanus Thompson that at present there is no such thing as a "best" machine. Almost all machines have good features, and they also have bad ones. A selective process must be followed by the electrical engineer in weeding out the bad from the good, and it is for this reason that the inner mysteries of the dynamo possess such an interest to him. It is by studying the actions and reactions in all cases that he will be enabled to determine how to make the "best" machine.

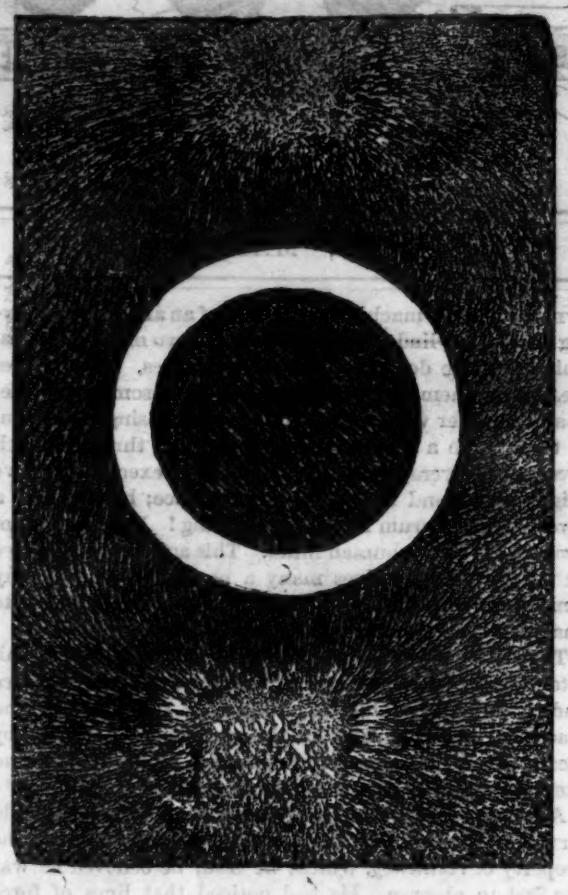

FIG. 4.

Improvements in Telephones.

Monsieur L. Maiche, a well-known electrician of Paris, has invented several improvements in telephones, etc., of which I will try to give American electricians a description. With regard to simplicity, the telephone as invented by Professor Bell is all that could be desired; but, unfortunately, it is subject to frequent derangements, mostly caused by the expansion and contraction, from atmospheric changes, of the pieces of which it is composed.

In the United States the cases of the Bell telephones are made of ebonite, while in Europe wood is substituted.

Fig. 1 represents the view and cut of a new disposi-

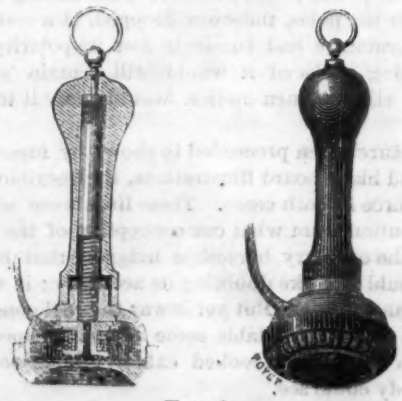

FIG. 1.

tion of this telephone. Here we find the top or cup part of the case made of brass, nickel-plated, into the lower part of which the permanent cut magnet-bar is screwed and rigidly held by means of a brass nut, as shown in the figure. The head of the magnet-bar terminates in a little soft iron bar, which goes through and forms the core of the bobbin. The diaphragm is held, as usual, by the cover and, lastly, the magnet-bar is inclosed in the wooden handle, the expansion or contraction of which can in no way affect the adjustment of the instrument. This new disposition gives a well-proportioned and handsome appearance to the telephone, assumes a permanent adjustment and gives excellent results as a receiver.

Figs. 2 and 3 show the front and side *views* of the microphonic transmitter of M. Maiche. The principle upon

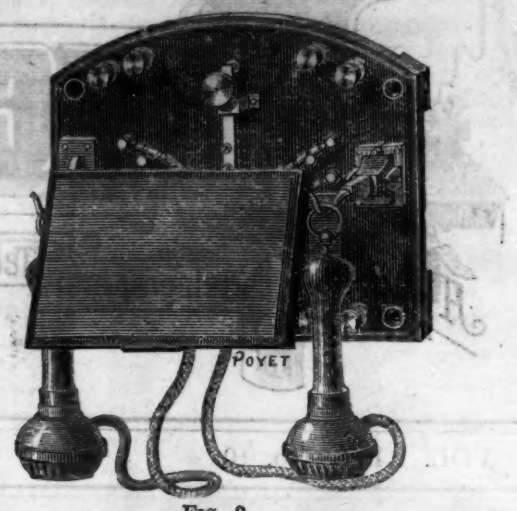

FIG. 2.

which it works is similar to that of the Crossley, Ader and other like telephones. The diaphragm is square in form and made of dry pine, on the under side of which is affixed

FIG. 3.

the microphone. This consists of three pieces of carbon screwed crosswise on the diaphragm, and twelve little pencils of the same material. These latter are *loosely* laid in the holes previously pierced in the cross pieces, the whole resembling a sort of gridiron, as shown in Fig. 4.

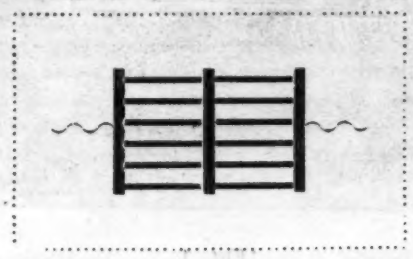

FIG. 4.

The primary circuit is connected to the right and left-hand carbon cross pieces. As there are twenty-four holes, there are consequently twenty-four contacts

Fig. 5 shows the exterior view of what M. Maiche calls his "electrophone." It is composed of a sort of

FIG. 5.

frame into which is fixed the microphonic diaphragm, induction coil, etc., with two of the modified Bell receivers on the outside.

The instrument is intended for long line telephony. It is said that conversation between Paris and Nancy—a distance of 220 miles—has been carried on through it with perfect satisfaction.

Of course the microphonic arrangement is the principal part. It consists of three, four and sometimes six distinct microphones fixed to the same diaphragm—a sort of compound microphone. Each of these microphones is composed of a swinging armature, on the end of which is a carbon ball. This ball rests against a thin pastil of carbon glued to the wooden diaphragm. All the pastils are

connected together, as are also all the swinging armatures.

Fig. 6 gives a view of the "pile Maiche." It is well-known that the action of most batteries is limited, as to durability, by the coatings of salts and oxides which, in time, will cover all metals attacked by acids, and therefore will offer a great resistance to the production and to

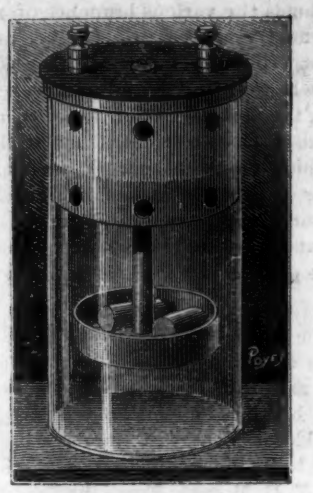

FIG. 6.

the passage of the current. This resistance becomes so great that the battery in time ceases to act. In the new battery the simple action of the air on the materials composing it suffices to cleanse them; so that the battery only ceases to work when the zinc is entirely consumed. This battery was fully described in a previous number of this journal.

I will mention one more improvement, which consists in transforming the batteries known as the "Leclanché peroxide of manganese battery" into accumulators of electricity. When one of these Leclanché batteries is worn out, it will suffice to send through its elements the current of a dynamo-electric machine, such as the Gramme. This current reduces the oxide of zinc, leaving the zinc in its former metallic state, and returning the oxygen taken from the zinc to the manganese; thus the battery is renewed and ready to work.

PARIS, France, Feb. 26, 1883. R. G. BROWN.

NOTE BY THE EDITOR.

We wish to correct here a prevailing error, in which also the writer of the above description appears to partake, namely, that wood is more subject to be influenced by such atmospheric changes as disturb the adjustment of the Bell telephone than is the case with ebonite. It is true that moisture affects wood transversely and not ebonite; but, on the other hand, heat affects ebonite very strongly in all directions and not wood in its longitudinal place, wherefore a pendulum made of a wooden rod is far less apt to elongate by heat and cause irregularity in a timepiece than a metal rod, and especially than a vulcanite rod, which is the worst of all. It is, therefore, a mistake to make the straight, long handle of the old form of Bell telephone of ebonite, because the heat of the hand expands it, and is apt to throw it out of adjustment, which it will not do when the handle is made of a kind of hard wood. Many who have compared wooden and ebonite telephones by practical use have found this out, and will agree with us that the wooden are the best.

Fundamental Principles of Electrical Science.

BY PROF. P. H. VANDERWEYDE, M. D.

No. 1.

Electricity is one of those branches of Natural Philosophy of which the history of its first discovery, and of the successive gradual additions to our knowledge of its mysterious properties, with the various inventions based on these discoveries, forms the best and most complete course of instruction which may be presented to those who desire a thorough knowledge of a force which is one of the most influential factors in the economy of nature, and promises to be a still more influential factor in the future higher civilization which is no doubt intended for the human race.

This close relation between the history of electrical science with the fundamental principles of the theory based on the phenomena which from time to time have been revealed to those who made the investigation the purpose of their life, has induced us to treat electrical science from a historical point of view, convinced as we are that the best way for individual man to attain a thorough knowledge is the same way which the intellectual portion of mankind passed through, while in the course of centuries it saw the science gradually develop itself, very slowly at first, but with the most marvelous rapidity in our day.

The slowness of the past development is strikingly shown by the fact that man had lived upon this earth for an unknown number of centuries, being utterly ignorant of the cause, origin or purpose of the most majestic electrical phenomenon, the thunder and lightning, which inspired him only with fear. It is not much more than one century ago that it was reserved for the American, Benjamin Franklin, to discover that it was a purely electrical phenomenon, but he found this by no means through his own unaided efforts, but by the labors of those who had preceded him for 2,330 years, and who gradually, one after the other, each adding his, sometimes apparently very small, but notwithstanding very important contribution to the stock of practical knowledge in this field of intellectual pursuit.

At the head of these men stands a well-known philosopher, Thales of Milete, who was born 640 years before Christ, and was the founder of the old Greek school of natural philosophy. He observed that when amber is rubbed it attains the property to attract light bodies placed at a short distance from it, and he came to the very natural conclusion that there resides in the amber a certain power which is related to the then already known magnetic attraction. Five hundred years later, Theophrasius of Lesbos, a pupil of Aristotle, continued the observations of Thales, about the power developed by friction in the amber, which being called electron in Greek has given rise to the name of electricity, which means amber power. This latter word was 150 years ago used in Northern Europe, and its translation is found in the books published at that period in Germany, Holland, Denmark, Sweden, etc. Theophrasius found that this power is not confined to amber, but exists also in other resins, sulphur, etc.; after this no progress was made for more than 1,600 years, a period during which all investigation of material nature was crushed, being considered as sinful; the only intellectual pursuits considered worthy of man's attention were literature and religious exercises, such as prayers, etc., with the practice of the arts, architecture, sculpture, painting, music and poetry.

But all this proved insufficient to elevate man kind out of what we now call the dark ages, and it was only the practical investigation of nature and the abandonment of theoretical speculation unsupported by experiment, that made an end to the deplorable condition in which man had sunk. It was chiefly the invention of printing in 1428 which was instrumental in placing human intelligence in more fruitful paths of pursuit, and after this great intellectual lever had done its work for 150 years, and induced investigation of nature by diffusing the knowledge thus far obtained, the English investigator Gilbert came forward and proved experimentally that electric attraction was a far more universal power than the magnetic and that it is destroyed by atmospheric moisture, which has no influence whatsoever on magnetic attraction; but he did not discover the polarity of electrified bodies, manifest by the electric attraction and repulsion, but considered electricity as a power which equally permeates the bodies.

Another century elapsed without progress, but then an influential step was made by the discovery that electricity will effect repulsion as well as attraction. This discovery, so highly important to the knowledge of the nature of electricity, was made by Otto Van Guericke, who explained it in a book entitled "Nova Experimenta Magdeburgica," published in 1672. He is also considered to be the first who made an electric machine, based on his discovery of the difference between good and bad conductors (the latter being called insulators) and the diffusion of electric charges over good conductors. Stephen Gray extended this knowledge by further observations on the propagation of electricity through conducting bodies, supported by non-conductors. He also demonstated practically that a hollow ball and a solid ball of the same diameter when charged equally with the same amount of electricity obtain equal charges, which proved that the electricity diffuses itself only on the surface of conducting bodies, and does not penetrate the interior. He finally showed that there is some mutual action between electrified and magnetized bodies, of which however the exact nature was only discovered 150 years later.

Half a century after Gray, the French investigator, Dufay discovered the two different electrical conditions, which determine the attraction or repulsion of electrified bodies, and he made the distinction between vitreous and resinous electricities, but this knowledge would have borne no fruit and no progress would have been made had not Benjamin Franklin appeared, whose penetrating mind when applied to this subject created a new era in electrical science, as from that time the discoveries have been manifold and the practial applications have followed one another in a continually increasing ratio. He showed that two electrically excited bodies attract one another when their electricities are of a different nature, and repel one another when their electric charges are of the same nature. He not only discovered the polarity and distinguished the two electrical conditions by the positive and the negative signs + and —, but also estimated their amount, viz., the intensity of the electric charges. He is the founder of the unitarian hypothesis in the electrical theory, while his contemporaries, the French Dufay and Coulomb, adhered to the dualistic hypothesis of two electricities, vitreous and pesinous.

The difference between these hypotheses is that Franklin supposed that all bodies have naturally a certain amount of electricity, which does not show itself until it is increased or diminished. When increased by some cause or other, it will tend to discharge itself on surrounding bodies, and we call it positively charged; when the natural amount is diminished it will tend to absorb electricity from surrounding bodies, giving rise to perfectly similar phenomena, and we call it negatively charged. According to the dualistic theory, there are two kinds of opposite electricities which, when mixed in equal quantities, neutralize one another by being balanced: one of those is the kind developed on glass when it is rubbed, and therefore called "vitreous;" the other kind is developed on resin when rubbed, and is called "resinous." Either kind will tend to discharge itself upon surrounding bodies and attract them, unless they are charged with the same kind to an equal degree, when it will repel them; while each kind also attracts all bodies charged with the opposite kind. This attraction or repulsion furnishes the means to distinguish one kind of electricity from the other, by simply suspending a light body, say a cork ball, by an insulating cord, say a silk string, and charge it with the electricity in question; if it then is repelled by a piece of glass excited by rubbing, it proves to be vitreous or + positive; when attracted it proves resinous — negative electric. Inversely when the charged cork ball is repelled by a piece of resin, sealing-wax or amber, which previously has been rubbed, it proves to be resinous — negative electric, and when attracted it proves to be vitreous + positive. The signs + and —, or the terms positive and negative, are used respectively for vitreous and resinous electricities, even by those who adhere to the dualistic theory.

We advise all who wish to become practically familiar with this subject, to repeat the experiments as far as referred to in this article; to provide oneself with a glass rod, and if this is not obtainable, a piece of glass tubing, filled internally with melted resin, for the reason that the least moisture in it will largely diminish and even annul electric manifestations. Rub this rod with a piece of flannel or leather covered with a very little of that cheap yellow bronze powder which is made of sulphuret of tin; this will produce positive electricity on the glass. A thick stick of sealing-wax rubbed with the hair of cat skin will do the same for obtaining negative electricity on the wax; having made those two preparations, some light bodies, such as pieces of straw, small feathers, pith or cork balls suspended or not, will be all that is needed to make a series of very instructive experiments, which it is needless to illustrate by figures. The main purpose of these experiments must be to verify practically what has been explained above.

The suspension of the cork balls by a conductory linen thread will teach the difference of a conductor and insulator, especially if the linen thread is attached to a piece of metallic wire, held in the hand, when it will be found to be always attracted by either positive or negative electricity, because it will be impossible to charge it, the human body being a good conductor of electricity. When, however, two cork balls attached to the ends of a linen thread are suspended from a glass rod in such a way as to touch one another, they will, when charged, possess equal amounts of electricity, and repel one another more or less, in proportion to the intensity of the charge. The amount of repulsion gives an approximate indication of the amount of the charge. Hence, they are used for the purpose of measurement, being inclosed in glass to keep off disturbing air currents; in this form they constitute the simplest form of electrometer, or electroscope, to which we will refer frequently in the future.

An Easy Experiment to Remove Frictional Electricity in Machinery.

The Boston *Advertiser* says that Mr. F. W. Whiting has found a way to obviate the trouble caused by the generating of electricity in cotton and woolen mills by the friction of the belts on the pulleys. The electricity being generated by friction is static electricity, which is of great potentiality, and therefore dangerous to the life of an employé if the machinery is accidentally touched when highly charged. When Mr. Whiting first began his experiments at the Armory mill, at Manchester, N. H., he found that the principal belt, which made 400 revolutions per minute, generated so much electricity that when the oiler attempted to oil the machinery he was almost paralyzed. Strange as it may appear, it only required the application of a very simple principle of electricity to remedy the entire evil. The earth is the great reservoir of electricity, and whenever there are proper conductors, the current finds its way by the shortest path to the ground. Going into the carding-room, Mr. Whiting attached a wire to one of the carding machines and carried the other end to the gas-pipe, to which it was fastened. Instantly all the trouble ceased, much to that gentleman's delight. While this probably would have been sufficient, he thought it best to draw off the electricity as rapidly as it was generated without its passing through the carding-machine; therefore he brought a rod of iron down from the ceiling to within a few inches of the belting, the upper part of the iron rod being connected with the gas or water pipes by a wire. At the lower end of the rod he fastened a brass bar, to which were attached a number of brass knobs, each an inch apart, they being brought up almost in contact with the belting. As fast as the electricity was formed most of it passed through these knobs, and thus through the iron rod, wire and water pipes harmlessly to the ground; and what little did not do so, after being transmitted through the machinery, passed through the first-mentioned wire. Thus, with two ground wires, all the electricity was got rid of, and the serious difficulties it occasioned were obviated.

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THE VARIOUS APPLICATIONS OF ELECTRICITY.

The number of industrial pursuits entirely based on the direct application of electricity is very large and is increasing every day, while those in which electricity is an aid of secondary importance, but very useful, is larger still. In fact, we appear to be reaching a period when there will be scarcely any pursuit not depending directly or indirectly upon this subtle agent.

The pursuits depending directly upon the application of electrical science are in the first place telegraphy and telephony and the manufacture of the apparatus, materials, and tools used in that now so important branch which gives an income to thousands and benefits millions of men. Next we have electrotyping, so important to the art of printing that we scarcely can do without it; electroplating is another pursuit of the most extensive application by reason of its great usefulness, enabling us to make metallic deposits on surfaces which it is impossible to cover in any other way. Then again we have generators of light for illuminating purposes, an art which at present is progressing at a rate unparalleled in the history of industrial enterprises; the production of high temperature for metallurgical and other purposes is another application, of which also surgery has taken hold for the application of cautery; while the modern medical art considers electricity in its diverse forms, properly applied, as a most valuable remedial agent. Next we have the transmission of power by electric currents, and last, but not least, the extraction of metals in mining operations, and especially for noble metals, where the value of the product justifies more expensive appliances; such as in the case of gold and silver.

Several years ago one of our American manufacturers of dynamo-electric machines for plating purposes announced that he would furnish such machines as were adapted to reduce to advantage copper from solutions obtained from certain copper ores. As long as galvanic batteries had to be used for the generation of electric currents, they were very expensive commodities, costing 1 lb. of zinc and 2 lbs. of acid for every 1,200 thermal units, but when electric currents can be obtained by the dynamo-electric machine at a far cheaper rate, the reduction of metals from solutions by means of electric currents becomes a practical process, as well as electric illumination, which was not practicable by galvanic batteries, for the simple reason that it was too expensive.

We hear now that Mr. G. Barker, of London, has succeeded in making an important improvement in the extraction of gold from its ores with the aid of the electric current produced by a dynamo machine, while the process has been adopted by the Electro-Amalgamator Company, and is in successful operation in Southwark. The improvement is based upon a discovery made long ago by Becquerel, in France, that a sufficiently strong electric current will correct the "sickening" of the mercury, which results, if the ore contains pyrites, such as sulphurets of iron, copper, or arsenic, and which "sickening" causes the mercury to lose its power for dissolving gold. This, of course, results in great loss, as thus gold is washed away which should be retained by the mercury. In order to aid our readers to understand this, we will only say that in the stamping mills the gold ore or gold quartz is crushed in contact with a little mercury, and passed with plenty of water over an inclined amalgamated copper plate, when the amalgam of gold and mercury will adhere to the plate, while the sand or crushed quartz will be washed away. The copper plate is then scraped off, the pasty amalgam put in a retort, and the mercury distilled off, when the gold remains as a porous lump. The invention of Mr. Barker consists in connecting the copper plate, which may have grooves or reeves containing some extra mercury, with one pole of a dynamo machine, while the other pole is attached to horizontal strips of copper, touching the water over the amalgamating mercury. The current thus produced will purify the mercury by causing the electro, positive metals or compounds to be driven out, and promoting the absorption, or rather solution, of the more electro-negative gold by the mercury.

It is well to add that Becquerel, in his system of extracting gold by amalgamation, only employed galvanic batteries, giving currents which were obtained at the expense of employing zinc, for the simple reason that dynamo-electric machines were not known in his time. The weakness of these currents and the great expense of making them stronger by colossal batteries are the reasons why the process has not been earlier introduced, and had to wait for improvements in the art to furnish cheap electricity in abundance.

This, no doubt, is only the beginning of a revolution in various metallurgical processes which we look forward to with confidence.

CONSIDERING that thousands of persons are connected with pursuits in which they would be benefited by a solid knowledge of the fundamental principles of electricity, and that such knowledge is often of paramount necessity, while very few have the opportunity of attending special courses of instruction in that science in colleges, even if we had them, which is not the case, we have concluded to commence in THE OPERATOR AND ELECTRICAL WORLD a series of articles for the benefit of readers who want to take up the study of electricity. The author will endeavor to explain in simple language those fundamental principles on which the science is based. As will be seen at the close of his first instalment, in this number, he recommends the reader to make the experiments described. We call special attention to this recommendation. No branch of natural science can be thoroughly understood by reading alone, nor the facts clearly remembered. This experimenting serves various purposes. Things which are seen impress themselves more clearly upon the mind than those only heard about or read about. The things seen remain better in the memory; in fact, are never forgotten by a normal brain, which may frequently forget things read; especially when perused without mental effort to understand them, and still more frequently when merely learned by heart as a lesson. This, by the way, is the great mistake most teachers of our public schools make, who pervert instruction which should train the mind into mere exercises of the memory, by causing the pupils to learn lessons in books in a parrot-like manner, without caring if the meaning be understood. There is another reason why experimenting is to be recommended; it trains the hands in doing and the senses in observing, as well as the mind in judging about the things observed, whether the experiment succeeds or not. The failure of an experiment teaches as much as the success, when the cause of the failure is traced; and it is especially for the latter reason that no one can hope ever to become an electrician by reading alone, without devoting some time to practical and extensive experimenting. Such as have occasion may with great benefit attend courses of experimental instruction. This is, of course, far better than reading alone, and in all schools the various branches of natural science, such as chemistry, optics, electricity, magnetism, etc., should be experimentally treated, instead of being disposed of, like history and other literary exercises, by books alone. Still, the best course of experimental instruction will not make so good a scientist as is the case when a learner sets his own hands to work, and arranges his own apparatus, or, still better, makes it himself. This is the way to the success achieved by Franklin, Ampère, Faraday, Morse and others; this is the way discoverers and inventors have pushed and worked themselves forward.

"ROME, the mother of civilized nations, honors in Professor Morse a young nation which is splendidly paying her debt to antiquity." These were the words of Signor d'Amico in his speech at the unveiling of the Morse memorial tablet in Rome last Monday—the homage of the Eternal City to the most illustrious American of our age, Professor S. F. B. Morse. From the Seven Hills the kindly sentiment comes across the sea, and is reverently dropped over the grassy mound at Greenwood. How well America is paying her debt to antiquity is best illustrated by the names of Franklin, Priestley, Henry, Morse, Edison, Bell and Gray. Professor Morse spent a year in Rome, and was charmed with the glories of Italy. He owed his success as an inventor as much to his artistic taste and love of form and symmetry as to his down-east laborious instincts; and, with a mind naturally refined, delicate and appreciative, he found everything to encourage its bent under the sunny Italian skies and amid Rome's wonderful records and relics. His home at Locust Grove, near Poughkeepsie, was built on the plan of an Italian villa, and of Italian decorations he was proud to wear the Cross of a Knight of Saints Lazaro and Mauritio.

THERE is no doubt but that at no distant day telegraph lines, at least in the large cities, will have to be put under ground, and that we must ultimately follow the example just set by Prussia, and now followed in many other countries, as well as in some of our own cities, and provide suitable subterranean cable systems. There is also no doubt but that then the interference of electric currents, which produce inductive influences, as well static as dynamic, and which now so much annoy those who use telephones, will then be largely increased by the necessary greater proximity of the wires. It is, therefore, important to give some attention to the means employed or suggested to overcome these difficulties. In view of all this, we believe that a translation of an instructive article by one of the principal electricians of the age, Count Th. Du Moncel of Paris, on the subject, and which we give in this number, will be read with interest by many of our readers. The article was called forth by the presence in Paris of Mr. O. Lugo of New York City, who is attempting to introduce his patent solenoid cable in France. It will be seen that Count Du Moncel's opinion is not favorable, but as a true scientist, he prudently adds that it is only his belief "until proper experiment has decided," meaning thereby that then his belief will become conviction either one way or the other. We may add here that Mr. Lugo's patent for the solenoid cable has resulted in a New York company, of which the stock has for some time past been a subject of extensive speculation in Wall street, fluctuating to the most extreme figures. According to the stock exchange reports, the shares of $100 have been as high as $1,000 or $2,000, and afterward down again, so that they were sold at $60—though they were never quoted at that figure—all according to the experiments being supposed or reported favorable or unfavorable; for a time the stock was unsalable, until lately, when for a short time it went up again, on rumored favorable reports from England and France.

A GOOD thing for speculators to remember is that after the Western Union had absorbed the American Union it was freely admitted that the former company paid more for the American Union than it was really worth, but that it was worth that much to the Western Union to get its lively rival "out of the way." The Western Union has now—in the face of the declaration of Dr. Green, made at the last annual meeting, that it would be necessary to buy up other competing companies—just paid $15,000,000 for the Mutual Union. The lines were, by its own showing, worth just half that much, as was shown during the argument on Mr. Reiff's suit on the 24th ult. In that case, Ex-Judge Green, for the Mutual Union, submitted the affidavit of Mr. William H. Fairbanks, a builder of telegraph lines, to the effect that the lines of the Mutual Union Company "were more valuable than any other lines he had constructed, except the Postal Telegraph, and were worth fully $7,500,000, and to the Western Union worth much more than that."

THERE are in the Signal Corps many educated and deserving men who should receive the full benefit of the law

which provides for the promotion annually of two of the enlisted force to the grade of Second Lieutenant. Since the Corps has been established there have been, we believe, only four such promotions, yet we are told, over the signature of the General of the Army, that General Hazen has at work "sixteen captains and lieutenants of the line, whose proper companies suffer in discipline and care for want of these very officers." Gen. Hazen can find many of his sergeants worthy of promotion, and he should, at least, abide by the letter of the law, which permits the promotion of two of them each year. It is the contrary course pursued by Gen. Hazen which has afforded Gen. Sherman the chance to write (December 30, 1881) with more truth than poetry that the Signal Service "has outlived its usefulness, and should be abolished."

THE Wheatstone department in the Western Union main office in this city was opened for business on the morning of March 1st. The results, so far, are considered quite satisfactory. The only circuit at present in operation is between New York and Chicago, with repeaters at Buffalo, N. Y. The Wheatstone system somewhat resembles the American Rapid automatic system in the manner of preparing messages for transmission, but the mode of transmission and reception of business is widely different. The maximum speed of the Wheatstone transmitter is about 250 words per minute. Mr. Jay Gould, General Eckert and others connected with the management of the Western Union inspected the system very thoroughly last Wednesday. During their visit Mr. S. L. Smith, of the Wheatstone department, perforated some business at the rate of 64 words per minute.

THE tablet just unveiled in Rome could not have better expressed Professor Morse's fame than in the sentence "The telegraph is his monument," thus calling to mind the words of the late William Cullen Bryant uttered twelve years ago: "Every telegraphic station is such a memorial; every message sent from one of these stations to another may be counted among the honors paid to his name. Every telegraphic wire strung from post to post, as it hums in the wind murmurs his eulogy. Every sheaf of wires laid down in the deep sea, occupying the bottom of soundless abysses, to which human sight has never penetrated, and carrying the electric pulse, charged with the burden of human thought, from continent to continent, from the Old World to the New, is a testimonial to his greatness. * * * * The great globe itself has become his monument."

EVERY operator has been annoyed in his time by the shocking chirography of some of those who patronize the wires, and therefore few of them will shed tears over the vexatious predicament of Mr. W. D. McAdoo. It was Mr. McAdoo they spoke of so highly, and who keeps the hotel in Greenboro', N. C., but when he ordered a pane of plate glass from a New York firm he wrote so wretchedly bad that "inches" were read "feet." The firm had to order the enormous glass from France, at a cost of $3,100, and Mr. McAdoo has now lying on the wharf at Norfolk the largest pane of glass in the world, one inch thick, and too large even for transportation over the railroad, since it will not go through a tunnel. He is in doubt whether to transport his hotel to Norfolk or the pane of glass to his hotel at Greenboro', but he freely admits the necessity of his practicing penmanship.

THE cutting of the Mutual Union lines by the authorities of Chicago and the threat to cut the Western Union wires on the first of May, if they shall not then be placed underground, seems to us like the exercise of despotic power and only second to lynch law itself. Chicago is a prosperous city, with many and intricate business interests connecting it with the outside world, and its merchants can scarcely afford to uphold their municipal officers in such wild and arbitrary measures. It takes time to bury the wires, but meanwhile an overhead line is better than none, and we believe that after isolating herself for a week from the telegraphic world, Chicago will ruefully admit the force of this argument.

WE were much shocked to hear a rumor that the gallant soldier-telegrapher, Col. John Lenhart, is the veritable "Number One" for whom everybody is on the alert nowadays. Colonel Lenhart is Number One in many respects, and should therefore not lose his temper, as did General McAdaras under this base accusation. The Colonel is a number one example of the old school operator—graceful but courtly, genial and rich in conversation, as ready with the pen as with the sword, and fond of a good dinner. It has been well observed that all great men have been good natured, and Colonel Lenhart enjoys life too well to spoil it by ill-temper over vile insinuations of this kind,

THE honors paid to the memory of Professor Morse in Italy this week, and the consequent re-awakening of many tender memories on this side of the ocean, reminds us of the well-known sympathy with and regard for the working operators cherished by Professor Morse. It was his intention, as we are told by Mr. J. D. Reid, to endow some annual memorial gift for the competition of the operators of America, a project which was prevented only by business entanglements. The idea is a good one, however, and may yet be improved upon by some philanthropic disciple of the Father of the Telegraph.

THE Postal line is making rapid progress, and with its capital of $21,000,000 to commence with will make a formidable opposition. In addition to reaching Chicago at once, its managers promise to construct trunk lines extending from New York to San Francisco and to all other large cities of the United States, Canada and Mexico, and to connect with Atlantic cables and with the Mexican and South American system of cables. There is plenty of room for such enterprise, and we hope to see it vigorously pushed.

ON Tuesday last the Senate of Pennsylvania made a vigorous protest against telegraphic consolidation by passing without a single dissenting vote the bill to escheat to the State the lines of companies which consolidate. The bill now goes to the lower house, but even if passed there and signed by the Governor it cannot be made to operate backward so as to cover the recent consolidation. An *ex post facto* law is unknown to our Constitution.

RATHER a queer wedding was celebrated in the Westchester County sheriff's office at White Plains, N. Y., March 7. George D. Williams, said to be an expert telegraph operator of this city, who had been "sent up" as a tramp, was the groom, and Kate Leviness, who had been incarcerated for disorderly conduct, the bride. They had become acquainted in the jail, and on being released were married, as above.

WE give in the present issue a very full synopsis of the recent lecture by Mr. Mailloux before the New York Electrical Society. The crowded state of our columns prevents our giving in this number Mr. Mailloux's regular instalment on electric lighting. His lecture, however, being really on the same subject, our electric light readers will not feel the omission so much.

THE recent consolidation, in putting an end to many tedious law-suits, also puts an end to much tiresome literature—the record of these legal proceedings—which very few ever read. The injunctions and quo warrantos and cross-suits made the dreariest kind of reading, and although we have printed the record as a matter of legitimate and current news, yet we are glad it is over.

DISSATISFIED stockholders, grumbling patrons, threatening State authorities and the liveliest kind of opposition promised in the near future, keep the great consolidated Western Union in hot water. It seems to have overlooked the fact that the field of telegraphic competition is like a crowded steeet car—there's always room for one more.

A LONDON paper, speaking recently of the purchase of the English telegraph lines, refers to that transaction as "a gigantic public robbery, in which many shared."

Canadian Notes.

The annual meeting and election of officers of the Bell Telephone Company of Canada was held on February 25th, in Montreal.

The project to construct a telegraph line from Chatham to Escuminac light-house, in the interest of shipping, is receiving the consideration of the Government.

On Tuesday night, Feb. 20, St. Lawrence street, from Craig to Lagauchetiere streets, Montreal, was lighted by the electric light for the first time. In a few days the street will be lighted up to St. Catherine street.

Mr. Benjamin B. Toye, the present electrician of the Great Northwestern Telegraph Company at Toronto, began as messenger boy with the old Montreal Telegraph Company in 1849, and was probably the first Canadian operator to read by sound. He was always known as an accurate and painstaking operator as well as a fine penman.

The Montreal *Shareholder and Insurance Gazette* says that Montreal Telegraph Stock has so far given no evidence of having been affected by the recent absorption of the Mutual Union by the Western Union. It is believed, however, that the transaction cannot fail to affect telegraphic interests in Canada, but to what extent or in what direction is not yet known.

Mr. W. J. Graham, the popular manager of the G. N. W. Company's offices in Montreal, has received leave of absence to spend a month or so at St. Augustine, Florida, for the benefit of his health. Mr. Graham has not had a holiday in a long time, and President Winan and General Manager Dwight have been very anxious that he should take this trip.

Any information as to the whereabouts of William McKenney will be thankfully received by his sister and relatives. When last heard from, about 14 years ago, he was employed in the Gold & Stock office in New York. He is 5 feet 8 inches in height, sandy whiskers and dark hair, about 48 years old. Address Mrs. McKenney, care P. O. Box 18, House of Commons, Ottawa, Canada.

The report of the Dominion Telegraph Company of Canada, for 1882, which has just been issued, states that the company has received from its lessees—the Western Union Telegraph Company—the guaranteed interest of 6 per cent. per annum, quarterly in advance, upon the paid-up capital of the company of $1,000,000; and likewise the full amount of the interest on the £60,000 sterling 6 per cent. bonds of the company; also, that these moneys have been promptly and regularly disbursed by the directors to the shareholders and bondholders of the company respectively.

The new weave shed of the Canada Cotton Manufacturing Company, at Cornwall was successfully lighted by the Edison electric light Friday evening, March 1. Over four hundred lamps will be required to light this building. Every one was delighted with the beautiful soft light. This weave shed is the largest in Canada, and is the first to use the Edison system in the Dominion. The electric light apparatus was built at Hamilton, where machines are now being built for several manufactories in both Provinces.

Mr. C. R. Hosmer, who has taken so active a part in telegraphic matters in Canada for several years, has just returned from a trip to England. When questioned upon telegraphic matters Mr. Hosmer said with reference to the Canada Mutual Company, of which he is president, and also regarding the cable scheme in connection with which he was in Europe, that matters are so much mixed at present that he is unable to say anything definite about them. Until the suit, which is now pending in New York, should be decided, matters would remain about as they are at present.

At Ottawa on Tuesday, March 6, a petition was presented by the Hon. J. S. Carvill, the Hon. Peter Mitchell, Josiah Wood, M. P., the Hon. W. W. Sullivan, A. C. McDonald, M. P., F. Brecken, M. P., and P. H. Davies, M. P., praying for the incorporation of the Canadian Rapid Telegraph Company (limited) for the purpose of using the recent discoveries in electrical science for the improvement of telegraphic communication between Nova Scotia, New Brunswick and Prince Edward Island, and to establish a new system of telegraphy in these Provinces.

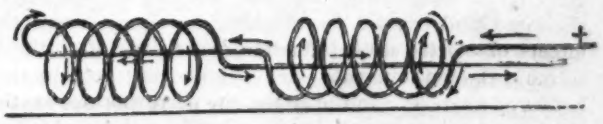
On the Various Systems Proposed to Prevent the Disturbing Effects of Induction.

BY TH. DU MONCEL.

Translated for THE OPERATOR AND ELECTRICAL WORLD from "La Lumiere Electrique."

The inductive effects which electric currents exert around the wires which transmit them are one of the greatest drawbacks encountered in telegraphy, and especially telephony. These effects, as is known, are of two kinds: 1st, those which result from the electro-static induction, and which are persistent; and, 2d, those which result from the electro-dynamic induction, and which give rise to instantaneous currents, which are nothing but the induction currents at present so largely used in various electrical applications.

The first-mentioned effects are produced when an electric current passes over an insulated conductor, which exerts a static induction upon all conducting bodies in its neighborhood, charging the same with electricity, causing an effect of condensation similar to that produced in a Leyden jar, and of which the result is to retard the duration



of the variable period required for the propagation of the current, while it exerts in all the conductors within the the radius of its influence an electric charge of the opposite kind. These charges, being in a more or less indirect connection with the prime conductors of the current, react on the same and cause secondary discharges which counteract the electrical results which are desired. These effects exist in all telegraph lines, but it is especially in submarine lines that they are manifested with the greatest force; they are, besides, in proportion to the energy of the primary current and to the extent of the inducting surface, consequently to the length of the cable, and generally inversely proportional to the thickness of the insulating layer which separates the conductor from the bodies influenced by the current.

The effects resulting from the electro-dynamic induction are of a very different nature; they are the consequence of the instantaneous changes in the electric equilibrium produced in the conductors near the one which transmits the current at the moment this current is closed or interrupted, or simply periodically modified in its intensity. These electric variations coptinually going on in a telegraph line, when in operation, result in ephemeral electric currents, which are in alternate opposite directions when closing or opening the circuit. The electro-static induction causes, therefore, a retardation in the propagation of the electric currents—that is, it takes a longer time for the current to attain at the other end of the line sufficient intensity to act upon the receiving apparatus, while the secondary currents which appear at the discharge of the line, and succeed the primary currents at the moments of their interruption, interfere with all the signals transmitted. The electro-dynamic induction causes the creation of abnormal currents in the neighboring conductors, which

more or less correctly may repeat the signals which are being transmitted by primary currents over the line.

It has been attempted to correct the first-mentioned kind of induction by means of alternately reverse currents of unequal duration, by establishing contact with the earth after every discharge, and by interrupting the line by condensers of large surface, and by causing the receiving apparatus to work simply by the difference of the charges. It is the latter method, which, with the use of a very weak battery, has furnished the best results on long submarine lines, but it has been necessary to employ receiving apparatus of the most extreme sensibility, such as reflecting galvanometers and siphon recorders, but notwithstanding all this, the duration of the transmission of the electric current has always been extended in great proportions. It was therefore of great importance to find means to annul the electro-static effects, and it is in this direction that the studies of many experimenters have have been directed, among them those of Mr. O. Lugo, of whom we will speak presently. In regard to the electro-dynamic induction, it has been attempted at different times to annul it, especially since the establishment of telephone companies, but thus far the success has been only partial. In 1878 Messrs. Hudges and Edison tried to annul the currents induced between telephone wires and neighboring telegraph wires, by passing at the transmitting stations the telegraph currents through peculiar helices, and these helices, in reacting upon other helices connected with the telephone lines in an opposite direction to the first, would create through these lines induced currents exactly in an opposite direction to those which become manifest in the two lines. Later it has been attempted to obtain an analogous result by using two wires for the telephonic transmission, one for the direct and one for the return current, twisting them one around the other, so that the induction taking place at regular intervals and symmetrically in the two wires, its action would be equal and contrary in each of them. The currents being in opposite directions they neutralize each other's inductive capacity. Better results were indeed obtained by this arrangement, but as the reaction of the two wires upon each other was not destroyed, the extra current which resulted therefrom was still a cause of disturbance, which has shown itself so decidedly as to prove that the problem was still incompletely solved. Others have attempted to weaken the inductive action by causing the closing and breaking of the current in the telegraph line in the neighborhood of telephone lines to be made gradually in place of suddenly. It is well known that the force of the induced currents is in proportion to the promptness and amount of the inductive action, and is therefore directly related to the duration of the variation which causes the induction; but such a system would require special arrangements for the purpose of telegraph manipulation, and it is doubtful if the telegraph companies would condescend to such changes. It is thus seen that the problem is not yet solved in an entirely satisfactory manner, and we will now see whether the means proposed by Mr. Lugo solves the problem more completely.

In his method, as in the former, Mr. Lugo proposes to annul all the effects of induction, whatsoever, by equal and opposite actions; he has not only to consider the electro-dynamic induction between different parts of the same circuit and neighboring circuits, but also the reaction of the same kind excited by neighboring circuits, and the effects of electro-static inductors, which manifest themselves between currents and neighboring conducting bodies as a whole. In the latter, the perturbations at the receiving stations are of the same kind as those obtained by the regular electric transmission, and it is the same with the extra currents resulting from the action of the return wire on the direct wire; but in the case of the action of the induction generated by the neighboring wires, the perturbations affect the currents which pass over these wires. Therefore a method is required which will completely destroy these three kinds of inductive actions, and Mr. Lugo pretends to have found it, by arranging the conducting wires of the circuit in a manner to satisfy the following conditions:

1. Exact equality of the resistance of the direct wire and the return wire.

2. Securing a strictly equal distance of all conductors (whether inductors or not) found in the neighborhood of the direct and return wire.

3. Such a disposition of the direct and return wire that no inductive action can be produced between them.

In order to obtain these results Mr. Lugo employs what he calls solenoid conductors. That is, in plain language, as seen in the adjoined figure, a straight conductor, of which one part is wound as a helix or coil around the straight part, so as to complete a circuit, of which one part covers the other, but in such a way that the central wire makes almost a right angle with that forming the coil, which is such a position that the electro-dynamic induction can almost not be developed. The straight part of the circuit can be considered as a portion of the direct wire, and the coiled part as a portion of the return wire, and in these conditions, as is easily seen, their mean distance from neighboring conductors is strictly equal. Two of the conditions above mentioned are therefore fulfilled.

As to the third, it may be solved by making the straight wire of a more resistant metal than the wire constituting the spiral, with respect to the mutual resistance of the two wires thus combined, or, what is better, in enlarging the section of the spiral conductor, which then may be made of a bundle of wires of the same diameter, rolled up parallel to one another.

In order to avoid the small induction which may result from the slight obliquity of the turns of the helix in regard to the axis at the straight part of the cable, Mr. Lugo disposes his two conductors in such a way as to form alternately the straight and coiled portions, but taking care that the solenoids of the direct and return wires are wound in opposite directions, so that the two conductors are alternately axial and helicoidal, which, according to Mr. Lugo, must neutralize any cause whatsoever of electro-dynamic induction between different parts of the circuit. According to a report of Mr. Pope, a distinguished electrician of the United States, published in New York, November, 1881, experiments were made in Philadelphia over a distance of a little more than half a mile with a subterranean solenoid cable inclosed in tin tubes of 2 inches diameter covered with asphaltum and buried 4 feet under the pavement of the street. He came to the conclusion that the result of the experiments left no doubt *in his mind* that it is possible to establish underground telephonic circuits of undetermined length without fear of disturbance by induction.

According to him one would believe that the problem of the suppression of disturbing effects caused by electro-dynamic induction was solved by Mr. Lugo in a more or less satisfactory manner. However, theoretically considered, there are still many exceptions to be taken in regard to questions of electro-static induction which could act upon the metallic tube surrounding the cable in its subterranean position. These effects can evidently not be very strong, as the earth is no part of the circuit, and cannot give rise to currents resulting from changes by condensation. These changes themselves, thanks to the alternation of the solenoids of the direct and return wires must tend to mutual destruction. This is true, but at the moment that they diminish or increase they must give rise to small electric waves, which will react upon the transmitting currents. In all cases the retardation produced by this kind of induction appears not to have been sensibly diminished, because it results from this induction itself. It is true that in the condition of subterranean cables this effect is less marked than in the case of submarine cables, because the insulating envelope of the wires is not in intimate contact with the surrounding conductor, which is the metallic tube; but the effect will be always perceptible, and the retardation in the electric transmission which is the consequence of it is easily understood, if we remember that the electro-static induction is, properly speaking, nothing but the effect of deviation of the current through all the dielectric mass which envelops the wires, and it is necessary that the effect be first produced, before the current passing over the wires can attain at the other end all the intensity of which it is capable. It is by reason of this retardation that the sub marine telegraphic transmissions are effected under the influence of currents which attain only a very small fraction of the electric intensity which corresponds with their permanent period of propagation, or rather, if the cell is charged, under the influence of a very slight decrease (or increase) of the normal charge of the cable. From this point of view, we do not think that the system of Mr. Lugo is very advantageous, and Mr. Pope himself, while pointing out the advantages which might result from the suppression of the electro-static induction, does not say that the system of Mr. Lugo has solved the problem. He says: "The conditions to be fulfilled differ not in their nature, but in degree from those which have been encountered and surmounted in telephonic experiments, and I foresee with the greatest confidence the important progress which soon will be made in this direction." We are, we must confess it, less confident than Mr. Pope. Whatever be the case, according to the experiments which Mr. Pope has seen, one would, to a certain point, think that the inductive electro-dynamic effects, so disastrous in telephonic transmissions, are almost overcome by the system of Mr. Lugo, and, from a theoretical point of view, this might be the case; but there remain the consequences which follow the electro-static induction, very harmful in subterranean conduits, and which in all cases make themselves perceptible by the weakening of intensity of sounds reproduced. If this was overcome, we would forever be free from the abnormal sounds which trouble all telephonic correspondence, and which are the despair of the subscribers to telephone companies. It need not be lost sight of that these advantages cannot be obtained without great cost, because the wires thus wound as spirals increase the resistance of the line in an enormous ratio (at least four times), and also their cost of construction; they make it necessary to use stronger batteries, larger microphonic apparatus, and then become more susceptible to be altered by sparks produced at the contact of the carbons. The spirals of the coiled conductor will, besides, develop extra induction currents between themselves, which may be annulled, it is true, by contrary effects resulting from the alternation of the spirals being wound in opposite directions, but which must increase the importance of the sparks at the transmitter. In short, it is impossible to decide about the real value of the invention of Mr. Lugo before experiments have been made on a long telephone line, placed under the ordinary conditions that telephones are applied. According to the report of Mr. Pope, there is only question of the experiments he records, made with telephones without batteries. It remains to be seen if the same advantages will be obtained with battery telephones, the only ones which are really serviceable for the telephone nets of cities.

At the end of his patent specification Mr. Lugo gives some explanations to show that by his system he can prevent the effects of electro-static induction. He pretends that in the two wires reacting at the same time upon surrounding conductors, the inductive action by one will be destroyed by the contrary induction of the other; but it is evident that the induction produced by the spiral must be more energetic than that produced by the straight interior part of the wire, because it has at the same time a much larger diameter and is nearer to the adjoining conductors. It is, therefore, the coiled part which will induce the exterior conductor, and as the inductive action divides itself, that which was made latent to cause electro-static induction, will be taken away from that which must balance the electro-dynamic induction. Moreover, like in electro-static induction, the electric charges induced are latent and unformulated. There may exist on the neighboring conductor a series of contrary static charges, which do not neutralize one another, as is demonstrated by the electric condition of an insulated conductor charged by induction, and which perfects two electrical tensions of opposite kind, which are kept separated by the same inductive action, and remain so as long as the latter lasts. We believe, therefore, until proper experiment has decided in this respect, that the method of Mr. Lugo can not be employed to correct electro-static induction, and also, as I have already remarked, that it will be of no use to overcome or destroy that serious drawback, the retardation and weakening of electric transmission, which is the consequence of electro-static induction.

The Postal Telegraph Company.

The *Sun*, of this city, gives the following account of the working of the Postal Telegraph Company: A great ticking of telegraph instruments was heard at 49 Broadway yesterday afternoon. It was accompanied by a musical humming resembling the vibrations of an old-fashioned tuning fork. The operators of the new Postal Telegraph Company were familiarizing themselves with their instruments. Six of them were sending dispatches to Cleveland simultaneously over the same wire. The musical vibrations were caused by the use of the harmonic system of telegraphy, each dispatch being sent on a distinctive note or sound. The ticking of the instruments was almost lost in the ticking of a dozen type writers, manipulated by as many charming young ladies. They were deciphering long slips covered with the characters of the Morse alphabet, and printing the dispatches received.

Nor were these the only tickings heard in the room. Seven copper cylinders, about two feet long, and of the diameter of a stovepipe, were ranged against the south wall. A young lady sat near each cylinder ticking the key of a sounder. The sounder was connected with a pen which was fastened above the revolving cylinder. At each tap of the forefinger on the sounder the pen recorded on the cylinder in red ink a character of the Morse alphabet. Each cylinder will carry 1,200 words. When the message is recorded on the cylinder the pen is withdrawn and an electric stylus dropped on the cylinder at the beginning of the message in red ink. Steam power is then applied. The cylinder revolves with great rapidity, and in a minute the 1,200 characters appear on a telegraphic strip of chemical paper at Cleveland, 800 miles away. The paper is wound in a roll the same as the strip in a stock indicator, and is ground out by hand in the same manner as an apple is pared by machinery. There were seven of these copper cylinders, and they could all be worked at once over the same wire. More than that, each could drop its dispatch at any station between here and Cleveland.

This is what is called the Leggo Automatic system of sending dispatches. The company claim that by it they can transmit 3,000 words per minute after the original dispatch has been transferred to the cylinder in Morse characters. For instance, a dispatch containing 3,000 words is sent to the office for transmission to a given point. It is cut into seven parts, or "takes," and distributed among the operators, the same as a printer distributes copy among his typesetters. Each operator transfers his "take" to a cylinder. When this is done the seven cylinders are set in motion, and the 3,000 words are transmitted simultaneously over the same wire. Thus the company has combined and perfected both the automatic and harmonic systems of telegraphy, discarding entirely the perforations that marked the introduction of the automatic system. It claims that it can send and receive eight dispatches at the same time over the same wire. By the distribution of its cylinders it claims that it can send dispatches direct to their destination from any city office without transmitting them to a central station. By the use of the harmonic system the wires cannot be tapped between the sending and the receiving stations. Under the Leggo system, messages can be transmitted automatically on a single wire, received automatically at the end of the circuit, and retransmitted automatically at the same speed over any number of circuits, all from a single setting on a cylinder.

The two wires in use between here and Cleveland are

steel, heavily coppered. They each contain over 500 pounds of copper to the mile. Each wire will sustain a weight of 2,500 pounds. The poles are thirty feet high and of unusual size and strength. There are forty of them to the mile. It is claimed that the wires are of such supreme conductivity that the electric current on them will not be disturbed by storms and atmospheric changes. The resistance to the electric current on these wires is only $1\frac{7}{10}$ ohms. It is averred that this brings Chicago, telegraphically, as near New York as Philadelphia, and San Francisco as near as Cleveland, compared with the best wires now in use.

The completion of the line to Chicago has been delayed by the spring freshets. Within a few weeks, however, the office in that city will be opened and the line thrown open to business. The company say that they will cut the rates to the lowest notch. They assert that they will be able to do the entire telegraphic business between the two cities on their two wires.

Underground Wires in the City.

In an interview recently, Superintendent Humstone, of the Western Union, said that so long ago as September last that company resolved upon the laving of an underground cable from the general office at Broadway and Dey street up to Twenty-third street, and gave out a contract for the work, which will be begun as soon as the frost is out of the ground. They have not at any time yet, however, contemplated running all their wires underground, and say that in the event of the passage of the Grady bill, making it compulsory upon them to do so, the inevitable effect will be the immediate abandonment of all the small offices that are now so great a convenience to the public, and the centralization of the business in a few principal offices. The company could not, Mr. Humstone said, bear the great expense of construction and maintenance of underground communications for some 150 small offices, and would not attempt to do so. They have in view now the double purpose of laying pneumatic tubes and wires under the section of Broadway specified. Two pneumatic tubes of brass or steel will be laid side by side at the bottom of the trench, and above them a five-inch iron pipe containing a cable, composed of 200 gutta percha insulated copper wires. This cable will be laid in sections of 400 feet in length, so put down that at any time a section may be taken up and replaced. The mending or substitution of individual wires in the cable will be impracticable. Inasmuch as various matters of detail are as yet unsettled, accurate computation of the expense is not yet possible.

Chicago Officials Cutting the Mutual Union Wires.

A dispatch from Chicago, dated March 3, says: "When the Mutual Union Telegraph Company was granted the right of way into the city a provision was inserted in the franchise obliging the company to remove its poles and to put its wires underground before March 1, 1883. This was not done, and to-day, by order of the Mayor, all the wires of the company at the southern city limits, fifty-eight in number, were cut, and police were stationed there to prevent the company from putting them up again. At the northern city limits the wires were also cut. The Board of Trade Telegraph Company has no franchise, and its wires north and south were cut, together with four wires leased by it from the Baltimore & Ohio Company. Thus the offices of the Mutual Union and the Board of Trade telegraph companies in this city were entirely cut off from the outside world, and one press association was prevented from getting its news inside the city limits except by messenger. The Mutual Union Company endeavored to comply with the provision and laid underground cables, but the project did not prove a success. City ordinances require all telegraph wires to be put underground before May 1, and the city authorities threaten, if this requirement is not complied with, to cut the wires of the Western Union Company at that time."

On the 5th inst. the Mutual Union Company began an an action in the United States Circuit Court against the city of Chicago, asking for an injunction to restrain its officers from interfering with the company in reconnecting its wires. The bill stated that the understanding of the agreement to have the wires underground before March 1 was not to be construed strictly, but was merely named as the time within which it was thought necessary experiments could be completed; that the company used due diligence and spent large sums in an endeavor to perfect the underground system, without success; that the Mayor, in causing the wires to be cut, did not act in good faith, as the city, police and fire alarm wires run on the same poles, and as he has since allowed one person to renew several connections.

After hearing argument, Judge Drummond held that the Mutual Union Company, having come into the city on an agreement that its wires should be laid underground before March 1, 1883, must abide by the terms of that contract, and that its right to carry wires on poles has expired by limitation. On the other hand, the Mayor of the city in causing the wires to be cut did an unlawful act. His course properly was to apply to the court for an adjudication of the contract. While, owing to the expiration of the contract, the court declined to issue an injunction, the terms of which would allow the wires to be connected again, he would, if the plaintiff desired, restrain the city from any further summary interference with plaintiff's property.

Mayor Harrison says the decision of Judge Drummond leaves him nothing to do but to station a force of police at the points where the wires were cut to prevent the company from reconnecting them. Superintendent Chapman, of the Mutual Union Company, says that under the ruling of the court the company can sue the city for damages.

Counsel for the Mutual Union, on Thursday, the 8th, asked that the city be compelled to reconnect the company's severed wires, with the privilege of afterward coming into court for the purpose of showing that the company's franchise had expired, and that under it the city had the right to remove the company's poles and wires. The argument was not completed at latest advices from Chicago.

Instruction in Electrical Engineering.

There is no doubt but that with all our practical progress in the application of electricity there is a great deficiency in thorough knowledge and correct information among those employed in the various pursuits in which electricity is an important factor, of which pursuits we have enumerated the most important in the leading editorial of the present issue.

Institutions where instruction in electrical engineering is made a specialty are, therefore, very desirable. Germany was the pioneer in this line, while last year one was established in London. Boston immediately followed, and founded one in connection with its Polytechnic Institute; but it appears that the small State of Monaco, in Italy, famous and prosperous for its gambling tables, is giving an example which we hope will stimulate other countries prosperous by honest means. We read in *Il Giorno*, published in Milan, that the new university for technical sciences in Monaco will have a separate department for electrical engineering, with ten popular professors, among whom Dr. Von Beetz will teach the theory of electricity and magnetism in general; Dr. Edelman will give a course of instruction upon the applications of electricity upon various technical manufactures; Dr. Bezold will teach telegraphy and telephony; Dr. Schroeter will give instruction in the theory and practice of dynamo-electric machines and the transmission of electricity. Dr. Kait will lecture on electric signals, and so on.

Italy to America.

Rome has honored herself in honoring the memory of the Father of the Telegraph. On the afternoon of Monday, March 5, the memorial tablet in front of the house formerly occupied by Professor Morse in that city was unveiled with appropriate ceremonies. We learn from a newspaper dispatch from Rome that the American Minister and the whole American Legation, Signor d'Amico, Director General of Telegraph, many prominent members of the American colony and other well-known persons were present. After speeches appropriate to the occasion had been made, the American Minister thanked the municipality on behalf of the United States, the American colony in Rome and all Americans for their action in causing the erection of the tablet. Signor d'Amico, in reply, paid a high eulogy to Professor Morse. In conclusion he said: "Rome, the mother of civilized nations, honors in Professor Morse a young nation which is splendidly paying her debt to antiquity." A detachment of Pompiers paid military honors on the occasion.

The tablet, which is very tastefully designed and elegantly worked, bears the following inscription:

S. P. Q. R.
In this house lived
SAMUEL FINLEY BREESE MORSE,
From February 20, 1830, to January 5, 1831.
HE WAS THE INVENTOR OF THE ELECTRIC TELEGRAPH.
Born in Charleston April 22, 1791. Died in New York April 2, 1872.

Telegraphic Litigation.

The application of Mr. Josiah C. Reiff, a small stockholder of the Western Union Telegraph Company, for an injunction to restrain the Western Union and Mutual Union Telegraph Companies from carrying into effect their lease, was argued on the 24th ult., before Judge Freedman. The complainant, through counsel, contended that the proposed lease was illegal, and that the directors had no authority to make it. By the lease the Western Union Company agreed to pay six per cent. interest upon the bonds of the Mutual Union Company, and to pay upon its stock interest of one and one-half per cent. He argued that the payment agreed upon by the Western Union Company to the Mutual Union was excessive. Judge Freedman then reserved his decision.

On the 2d inst. Attorney General Russell denied an application made by Mr. Reiff for permission to bring suit to annul the charter of the Western Union Company—an action similar to that recently brought against the late Mutual Union. In denying the application the Attorney General says that in the case against the Mutual Union the charge was that the unlawful increase of stock from $600,000 to $10,000,000 did not represent a dollar of property, and that the whole $10,000,000 was turned over to the construction contractors to evade the law requiring capital stock to be actually paid and to enable these contractors to divide the proceeds derivable from the sale of the unlawful stock among some of the directors of the company who were interested in the construction contract. These allegations, the Attorney General adds, "were not substantially denied upon the contest, and the courts agree with the Attorney General that such averments, uncontested, called upon the State to act and vacate the charter of the company."

In the present case he says that while the fact of the increase is admitted, the Western Union denies that it wa illegal. No charge of fraud whatever, he alleges, is made in connection with this increase, and both the Special and General Terms of the Superior Court in the Williams and Hatch cases find that there is no evidence of fraud whatever, and the testimony in these cases and such as was given before the Attorney General indicates that the increase was made upon substantial and corresponding values.

In the action of Frederic Bill, of Groton, Conn., against the Western Union Telegraph Company, Gold and Stock Telegraph Company, and others, touching a lease of all their estate issued by the Gold and Stock Telegraph Company to the Western Union Telegraph Company, argument was heard on the 3d inst., before Judge Wallace, United States Circuit Court, on the motion to make the injunction permanent restraining the former-named company from disposing of or in any way interfering with the property alleged to have been leased to them by the Gold and Stock Telegraph Company. Mr. Bill, who is the owner of 275 shares of the capital stock of the Gold and Stock Telegraph Company, avers that the lease, so far as the company in which he is interested is concerned, was "grossly unconscionable," and he prays among other things that the Court will decree that the Western Union has no lawful right to receive any property so transferred to it under terms of the lease. An accounting is also asked for. The Court took the papers and reserved decision.

DEPARTMENT OF INQUIRIES.

As we frequently receive inquiries for information in regard to electrical science and its practical application, we have concluded to add to the departments of our paper one exclusively devoted to answering inquiries, even such as are only remotely connected with electricity. Such department will serve a double purpose; firstly, the answers will give the desired information to correspondent; secondly, the nature of the questions may frequently be an indication of the intellectual need of our readers, and show what special subjects would be most acceptable; consequently the department may be of mutual benefit.

(1) STEEL WIRE FOR TELEGRAPH LINES.

What is the resistance in 100 miles No. 8 steel wire? Do you know of any special reason why steel cannot be used provided the size is increased sufficiently to equal the conductivity of a No. 8 or 9 iron wire? C. D.
ST. LOUIS, MO.

The resistance of No. 8 steel wire is 17 ohms per mile, and, therefore, 1,700 ohms per 100 miles. It must be observed, however, that steel varies largely in its conductivity, in proportion to its chemical composition, namely, its amount of carbon, and the presence of other metals, such as chromium, manganese, etc., which may improve its qualities as steel, but very much injure its conductibility. So while pure iron has only a resistance of 4.82, pure copper being 1, impure iron has a resistance of 5.95, and steel of 6.25 to 6.50.

The special reason why steel is not used is purely the greater cost, which is increased as thicker wire is required, No. 6 and 7 steel being about equivalent to No. 8 and 9 iron wire. You are perhaps aware that there is a patent for steel wire telegraph conductors, in which the steel is surrounded by copper to increase its conductivity, and shield it against rust. It has the advantage of greater strength by smaller wire, and better conductivity, No. 12 or 13 wire being about equivalent in all respects to No. 9 ordinary wire. It has, however, the disadvantage that where moisture reaches the steel core it is iron oxidized by the galvanic action set up by the copper. This was the experience of the New York Police Telegraph some years ago, it is now, however, tried again by the Postal Telegraph Company with a wire more carefully manufactured and it is hoped that this will last a long time.

(2) ECONOMY IN ELECTRO-MAGNETISM.

Will a single coil or two coils have the greater power when arranged as follows:

Single coil, 200 ohms resistance, extending the core from each end to act on the armature.

The double coil to be same as in the ordinary Morse relay each coil to have 100 ohms resistance.

The wire used in single coil to be half the size of the other; that is to say, the outside convolutions of the single

to be no further removed from the core than the double magnet used to compare it with. FELIX.

The magnetism developed in the core of a magnet is proportional to the number of turns of wire and the amount of current in the circuit. It is presumed in this case that both these factors remain alike, and consequently the magnetic intensity of the core ought to be the same for both. But the amount of magnetism available in producing attraction is not necessarily the same, for it depends on entirely different conditions. A magnet is an aggregation of lines of magnetic force issuing from one end of the core and circling around to join the lines at the other end so as to form closed circuits. Iron has the power of concentrating and condensing these lines of force, but when they are at a distance from iron they exert a mutual repulsion among themselves that makes them scatter. If the two poles of a magnet are close to each other their course never extends far from the iron, as they cross from pole to pole, and consequently their self-repellant properties are overcome; they do not scatter apart from each other to any great extent, and the nearer the poles are to each other, the more concentrated will be the lines of force there. The U-shape of magnets is specially adapted to the closer disposition of the poles, and therein lies its superiority. Thus, though the magnet represented in the figure might develop an equal number of lines of force as one made U-shape, the distribution of these lines of force would not be as dense between the poles, simply because their mutual attraction and consequent neutralization would cause them to scatter more in passing across a distance so much greater, between the poles; in fact, a large number of them would not pass from pole piece to pole piece at all, but would circle around on all sides just as in an ordinary bar magnet.

It has been found, practically, that these magnets are not so powerful as those of U-shape, which confirms this theory. However, they are occasionally used from the convenience of their shape in certain adaptations. Undoubtedly it would improve them considerably to prolong the pole pieces inward, as shown by the dotted lines; for in this manner the number of lines of force passing from pole piece to pole piece would be greater, and they would be less scattered by mutual repulsion.

(3) DEPOSITS AND OVERFLOW IN LECLANCHÉ BATTERIES.

Will you please answer the following questions:

1. While looking at a porous cell Leclanché battery the other day, I noticed a black sediment in the bottom of the jar. This sediment had a slimy appearance, and I noticed round particles in it that looked like quicksilver. There was nothing the matter with the porous cell. It was whole and in good condition. Now what was the cause of the sediment, and does it weaken the battery by being there?

2. I also notice in the above kind of battery that the water often runs over the top of the jar and gives it a dirty appearance down the sides. I know this can be caused by filling the jar too full, but I would like to know what causes it to run over when the jar is not filled too full of water. "235," New York City.

(1) *Deposits in Leclanché Batteries.*—The black deposit you speak of consists of impurities of the zinc, which are insoluble in the solution of chloride of ammonia. The shining particles are probably mercury, with which the zinc dissolved was amalgamated; you can test this with a small chip of sheet tin, to which mercury will adhere. We don't think it advisable to amalgamate the zinc in Leclanché batteries.

(2) *Overflow of Leclanché Batteries.*—You must never fill a Leclanché battery more than half or at most two-thirds full. In a moist room the service cup, which is watered with the solution, will attract moisture from the air and cause at last the battery to have more liquid. If you find this to be the case, pour out the liquid, clean the battery from all sediment, if you think it does not weaken the battery; it surely does no good. What weakens the battery is this: At last the liquid becomes all chloride of zinc, and that is the end of the electric action. The modern form of this battery, without porous cup and with a cover, is better; it has a cover, and is therefore cleaner also.

(4) THE ELECTRIC LIGHT IN AN ISOLATED HOUSE.

I have just finished me a nice home here, and would like to have in my parlor, more for the novelty of the thing than anything else, an electric light. Can you tell how I can have one without costing me too much? Would only want to use it occasionally, and in that one? room. I have gas all through house.

W. H. A., Rome, Ga.

It appears that our correspondent is not aware that electric light cannot be obtained, except by a powerful galvanic battery, which is exceedingly expensive, or by a dynamo-electric machine, which is much cheaper in the long run, but which costs horse, steam or water-power to drive it. To illuminate a single room would not be worth the expense, as the plant to furnish electricity for a few lamps would cost several hundred dollars, but by an insignificant increase in the cost it may be made to illuminate 20 or 40 rooms. If you use galvanic batteries the first cost is much less; $100 may give you a battery for one lamp at a cost of only $4 or $5 per night, not to reckon the trouble of cleaning the wires, etc. You would have to hire a man to attend to the battery, and he must be a man who understands it, and he would charge in proportion to his knowledge.

The incandescent lamps cost $2 apiece, the arc-lights $60 each. This is in addition to the plant of $100 for battery; or $600 for small dynamo machine and steam engine. The large ones for 15 lights cost with the lights about $2,000.

This inquiry reminds us of several others we received several years ago, when the Electric Light Company announced that the lamps would cost only 25 cents each. One party remitted $3 for a dozen electric lamps, asking at the same time what kind of oil should be burned in them, and there are still many persons who do not realize that the lamp or bowl is only a very small item in the process, but that the connections to them at the other end of the wires which feeds the lamps are the principal and costly feature of electric light.

(5) SOME POINTS ON ELECTRO-MAGNETISM EXPLAINED.

Electro-Magnet, Boston, writes: Will you be so kind as to inform me, either through the columns of your valuable journal or by mail, as to the correctness of the following deductions, which I have made from a recent study of Ohm's law and the laws of electro-magnetism.

I have 12 cells of battery. Each cell has an E. M. F. of 1 volt and a resistance of 3 ohms. When arranged in simple series, in circuit with an electro-magnet of 36 ohms resistance (*no line resistance*), I get a certain magnetic force. If this battery, arranged in multiple arc, in 3 files of 4 cells each, is in circuit with an electro-magnet of 4 ohms resistance, will the magnetic force be the same as before, it being understood that the two magnets are identical as respects the dimensions of core and spools and *weight* of wire, the *diameter of wire* only being different?

I figure it as follows: If an electro-magnet of 36 ohms resistance has 600 turns of wire wound around its cores, then this same magnet, if wound to the same *weight* with a wire whose total resistance amounts to 4 ohms, the number of turns will exceed 200.

Take the first arrangement. Strength of current $= \frac{E.\,M.\,F.}{Resistance} = \frac{12}{36+36} = \frac{1}{6}$ ampère strength current $\times$ number turns $=$ magnetic force $= \frac{1}{6} \times 600 = 100$ units *m.* force.

Second arrangement would give $\frac{4}{4+4} = \frac{1}{2}$ ampère, $\frac{1}{2} \times 200 = 100$ units magnetic force. Is this right?

Also, will you please inform me why the resistance of the instruments on a telegraph line is generally so small compared with line resistance, when all books on electricity state that the best results are obtained when the resistance of the magnet or magnets equals the resistance of all other parts of the circuit?

If there are books which state that the best results are obtained when the resistance of magnet or magnets equal the resistance of all other parts of the line, it is a very erroneous statement; the truth is that in order to obtain the best results, the resistance in the *battery* should, as much as practicable, be equal to the sum of the resistances of the line with those of the magnet or magnets along all parts of the circuit. A long line of great resistance requires, therefore, a great number of cells connected in simple series for intensity in order to overcome the great resistance of the long line; this resistance, however, weakens the current to such a degree that it cannot act upon instruments with few turns of the coil, but requires instruments with many turns of finer wire, and more in proportion that the resistance of the line is longer, but by no means having a resistance equal to that of the line; in fact a resistance of one-tenth of that of the line is a usual practice, but it may be a great deal smaller still.

Sometimes the resistance of a line is found in practice less than that given by theory, but this is simply due to imperfect insulation; that is, to leaks along the poles, and therefore variable with the weather. But such a diminution of resistance does not allow a diminution of battery power; on the contrary, it requires an increase so as to allow the current to reach the extremities of the line, which on unfavorable days are not reached with sufficient intensity to act upon the instruments.

In regard to your calculation, this is correct in so far as it goes; you may go a step further and connect all your cells, zinc to zinc, so as to act as a single cell of only $\frac{1}{12}$ of 18 ohms, or $\frac{1}{4}$ ohm resistance, when you will have a third arrangement: $\frac{1}{\frac{1}{4}+\frac{1}{4}} = 2$ ampéres, showing that because $2 \times 50 = 100$, 50 turns of a wire of $\frac{1}{4}$ ohm resistance will do the same thing.

THE ELECTRIC LIGHT.

A Fort Wayne saloon-keeper ordered the electric light removed from his establishment because he couldn't light it with a match.

The Western Union Building in New York is to be illuminated by the Edison electric light. The wires will be extended from the central station under John street across Broadway. The intention is to illuminate this centre of electrical activity in such a manner as to illustrate that for interior illumination electricity has achieved as great a success as it has for the purposes of the transmission of thought.

Western Union stock was particularly strong on Wednesday, owing to a rumor that the executive committee at its meeting that day would recommend an increase in the rate to 1¾ per cent. The recommendation of the committee will not be officially made until next week, but it is stated on excellent authority that the committee on Wednesday decided to recommend an increase to the rate of 7 per cent.

ELECTRIC ILLUMINATION OF MINES.—The famous Rio Tinto mines, Estramadure, Spain, have been provided with electrical illumination by Siemens Brothers, of London, by means of arc lamps. The mines are open, and, being situated on a steep incline, two powerful lights are used, with reflectors throwing the light in the desired direction and making it possible to throw it in most of the excavations. Other arc lamps are used for the grounds around and the buildings. The whole installation was a great success and reflects credit on the firm, who appear to do a gigantic business in different countries.

The New England Weston Electric Light Company is setting up machinery in Portland, Me., for incandescent lighting. The company already has orders for a large number of lights. The *Daily Press* offices in that city are now lighted by the Edison incandescent electric lights, and they give excellent satisfaction.

The Arnoux Electric Light Company has just increased its power at Portland, Me., by the addition of two new 85 horse-power boilers; two Fitchburg automatic cut-off engines, and much new shafting of an improved pattern. This company is receiving much encouragement in Portland. It has also established stations at Gardiner, Lewiston, Auburn, Saccarappa and Cumberland Mills.

Mr. Sparrow, the Electrician of the Arnoux Electric Light Company at Portland, Me., was severely injured a few days ago, by falling from a high beam in the dynamo room, where he was superintending some work.

Mr. F. A. Johnson, chief of construction for the Weston Electric Light Company, Portland, Me., has invented a unique device for pointing carbons, which he will patent.

TELEPHONE DEPARTMENT.

A SIGN OF THE TIMES.—The telephone exchange at Portland, Me., is about to move into spacious rooms, which are now being got ready. Heretofore the exchange has been cramped for room, but in the new quarters there will be ample space and room for development. The operating room will be in the fourth story of the W. U. building and the offices are directly underneath.

All the telephones on the talking circuit in the different fire engine houses in Newark, N. J., were burned out one night last week by electricity. The accident was caused by the contact of the Fire Department wire with an electric light wire. The shock was felt in the central telephone office, when all the indicators suddenly dropped. The current was so strong in the office of the superintendent of Fire Alarms that the wood-work surrounding the instruments burst into flame. In some of the engine houses the men were driven out by the play of electric flames. Let the telephone protecting devices be brought forward.

Messrs Ingham, Glidden and Downs are, of course, at the head of the latest purchase of the Lowell syndicate, referred to in our last issue. Mr. Downs has already sent one of his best Eastern superintendents to take active charge of the new territory. It is said that in it there are at present 1,500 paying subscribers, but that the development is far from what it should be, and what it will be with the coming nine months of outdoor work that will be done. The great source of revenue, extra territorial business, which the Lowell managers were quick to discover, has a promising field in the new territory and will only be delayed until weather will permit operations. One of the Lowell papers, referring to the subject, says: "The purchase has the look of the heaviest operations the Lowell management has ever been concerned in, and is likely to prove what President Ingham intimates in his telegram—a bonanza."

A new board of directors and new executive officers—the latter being Messrs. Ingham, Glidden and Downes—were elected at Minneapolis, March 5th. At the same meeting it was voted to amend the by-laws so that the authorized capital be increased to $2,000,000 (dividend-earning capital $550,000). Hereafter all meetings of the company will be held at Lowell. "It is a matter worthy of comment," says the Lowell *Times*, "that when Mr. Ingham returns to Lowell on Saturday he will find the entire limit of stock previously decided to be placed upon the market sold and paid for. This amount exceeds 3,000 shares. The Lowell syndicate pay cash for the new property."

DASHES HERE AND THERE.

A BOAT PROPELLED BY ELECTRICITY.—There has just been completed in France, a boat which is to be propelled solely by electricity. M. Tellier, the owner, intends to launch it at Boulogne, and to cross in it to Folkestone, in company with a friend. The boat is about 18 feet long by about 4½ feet wide.

In the Pennsylvania Senate at Harrisburg, on March 6th, the Senate bill to escheat to the State the property of telegraph companies which consolidate with competing lines was again considered, and passed finally by a vote of 39 yeas; nays, none. The bill was then sent to the House for concurrence.

The citizens of Greenpoint, N. Y., are much pleased over the perfect police and fire alarm system to be introduced there by the Greenpoint District Telegraph Company, recently organized by Haines Brothers of this city. Mr. Harry Balston is president; Wm. P. Miller, vice-president; F. H. Skeele, secretary and treasurer.

It is said that the Cleveland, O., District Telegraph Company's wires are constructed so perfectly that a break has never occurred upon the lines. Mr. H. H. Doherty is the general manager. Messrs. Thos. Grimes, of the Troy District, and L. J. McVicker, of New York, are also connected with the Cleveland Company.

A London, England, paper, in speaking of overhead telegraph wires, says that "there are over a thousand in one city street. It is well to remember that a snapped wire would cut a man's head off. In 'wintry' weather people walk about the streets in more imminent peril of their lives than if they were in the midst of the Atlantic."

A petition, the signers of which represent $50,000,000 of Boston capital was recently sent to the Western Union Company in this city, praying that the services of Supt. D. J. Hern, of the Mutual Union, be retained by the Western Union. The petition shows the esteem in which Mr. Hern is held by Boston business men.

A resident of Bismarck, Dak., recently received a telegraphic order from Carbon, which he proceeded to fill. He skirmished about town and finally succeeded in getting six cats together in a box, which he properly labeled and

left at the express office. He then telegraphed "Cats send by express to-day." To his surprise, however, he discovered that it was "cots," not "cats," that were wanted. We are requested to say that the "bull" was made in the railway-office, not in the Western Union.

STOCK QUOTATIONS.—Telegraph, telephone and electric light stocks were quoted as follows on Wednesday:

	Bid.
Western Union Telegraph	83⅝
American Cable	65
American District Telegraph	38
Bankers and Merchants' Telegraph	120
Edison Electric Light	450
U. S. Electrical Light	131½
Fuller Electrical	33
Mexican Telephone	4¼
American Bell Telephone	275½

THE Montreal *Shareholder* says that a suspicion widely prevails in telegraphic circles in the United States, that the Washington authorities have it seriously in contemplation to adopt a system of postal telegraphy, and that a disposition prevails to buy out existing companies rather than erect new lines. This fact, if such it is, must, says the *Shareholder*, be within the knowledge of those who have just brought about the amalagamation of the Mutual Union with the Western Union Company, and it is said to be simply with the desire, on the part of the new lessors, of selling out soon to the U. S. Government at a large profit that the Mutual Union has been virtually extinguished.

TELEGRAPH LINES ON SUBSIDIZED RAILROADS.—In the House of Representatives at Washington, on the 27th ult., the Speaker laid before the House a letter from the Secretary of the Interior, in reply to a resolution calling for information concerning telegraph lines along railroads subsidized by bonds or lands. The letter was accompanied by a report from the Commissioner of Railroads, which states that replies to inquiries as to telegraph lines have been received from the Union, Central, Southern and Northern Pacific roads, stating in each case that all laws in reference to telegraph lines on those roads have been complied with.

THE TELEPHONE FOR DIVERS.—It appears that the suggestion made some time ago, that the telephone would be useful for rapid intercommunication between divers in the bottom of a stream and the persons assisting them in the boat above, or from the shore, is being tested with very favorable results. Among other localities it is reported that conversation with divers at the bottom of the London docks was carried on with great facility, while those on the bottom of the Thames ordered which tools were to be sent down, asked and answered questions, etc., so that this is another of the successful applications of the most popular invention of the age.

NEW YORK CITY ITEMS.

Echoes from 195.

Mr. Ed. A. Keene, Jr., has gone to Oil City, Pa.

Mr. A. J. Voyer is visiting his parents in Washington, D. C.

Mr. William Taylor is at present in Saratoga, N. Y., on company's business.

Messrs. J. H. Young, T. H. Collins and A. H. Inglis have resumed work in 195.

Messrs. John Mitchell and P. J. Morrison have been away on leave of absence.

The Edison incandescent electric light is now being introduced into the operating room.

Mr. Wm. O'Hearn, of the day force, is a member of the New York Produce Exchange.

Letters from Denver, Col., state that Mr. J. W. Moreland contemplates going to New Mexico.

Mr. F. M. Thompson has returned from Boston, where he has been visiting for two weeks.

Messrs. Jame F. Crate and G. H. Getz work the Hartford quad. Mr. Crate continues to turn out the same "gilt edge" copy as of yore.

Mr. John B. Hurd, of the Cleveland quad, was made happy last Saturday by the receipt of a letter from a brother in Australia, from whom he had not heard for 33 years, and of whose whereabouts he had been entirely ignorant.

Mr. Frank B. Rae, formerly of 195, but for several years connected with telegraphy and electric lighting in California, arrived in the city from San Francisco on Thursday, March 8, looking well. He will remain East for about two weeks, looking into several electrical matters with a view to their introduction on the Pacific Coast.

Mr. Oscar Kraft, who works No. 39 south, is a model for punctuality, not having been late in several years. Mr. Kraft formerly worked in the old New York & New Haven depot, Twenty-seventh street and 4th avenue. Upon leaving that office to engage in other business, the operators on No. 6 east presented him with a valuable gold-headed cane as a mark of their esteem. Mr. Kraft is equally popular on No. 39 south.

Last Sunday Messrs. P. J. Keliher and C. M. Fulton, of the first Chicago quad, walked from Brooklyn to Coney Island. The walk developed Mr. Keliher's appetite to such an extent that he ate a one-dollar dinner on his arrival. Of late Messrs. W. C. Ward and F. E. Briggs, of the clerical force of 195, have also been indulging in long pedestrian tours. Recently they walked to Yonkers, N. Y., Orange, N. J., and Morristown, N. J., on each occasion returning to New York by train after a hearty supper.

Other City Items.

There not being a quorum present at the meeting on March 2, the annual meeting for the election of officers and standing committees of the New York Electrical Society for the ensuing year was postponed until Friday, March 9, 8 P. M.

The case of W. S. Mack, of the 66 Gold street W. U. office, ought to be a warning to those who prefer to buy second-hand instruments rather than pay for new ones. Mr. Mack advertised in the Sunday *Herald* for telegraph instruments. William Gifford asked him if he would buy four sets. He replied that he would, and would pay $2 for each sounder and $1 for each key. Gifford brought the instruments and was paid the $12. It subsequently turned out that the instruments had been stolen from the American Rapid office. Both Gifford and Mack were arrested and locked up in the Tombs. Mack retained a lawyer, paying him more than the cost of the instruments when new; but when the case came up the justice discharged him, it being shown that he had no knowledge that the goods were stolen. Gifford, however, was held for trial. It is to be hoped that when Mr. Mack next wishes to purchase telegraphic instruments he will buy them new at a regular supply house, and not advertise for second-hand ones.

PERSONAL.

HERMOSILLO, MEXICO.—Mr. C. A. Mitchell has been appointed master of transportation and superintendent of telegraph of the Sonora Railway Co., with headquarters at Hermosillo, Mexico.

COLUMBUS, O.—Messrs. Geo. Cole, L. M. Owings, A. M. Paddock, E. S. Rose, J. M. Zigler, J. W. Cloud and Lewis W. Boyer are the Committee of Arrangements of the Columbus Telegraphers' ball, which takes place March 26.

If Robert C. Fulton, formerly of Pittsburgh, Pa., will address the undersigned, he will hear of something to his advantage.

B. W. FLACK,
Standard Oil Company, Pittsburg, Pa.

FRANK P. BROWN, aged thirty-seven, an operator in the employ of the Western Union Company, was found dead in bed at Bradford, Pa., on the 3d inst. His death is supposed to have resulted from congestion of the brain. He leaves a wife and two children in Buffalo.

Information is desired of the present whereabouts of Mr. Riley M. Johnson, last heard from Oct. 7, 1880, at Shumway, Ill., as operator for the I. C. Ry. He then spoke of going to the Arizona gold mines. Any information sent to this office will relieve the uncertainty of his mother and relatives as to whether he is alive or dead.

DES MOINES, IOWA.—The Western Union office at Des Moines has been recently destroyed by fire. The new office is located in Mill's Block, on Fourth street. The present office is much improved, and is now undoubtedly the largest and best office in Iowa. Mr. T. A. Yearnshaw, its manager, is one of the most popular telegraphists in the State, and widely known throughout the country. He is a favorite—is well favored among the business portion in this city. Mr. John J. Chaddick, who has been a resident of Chicago for the past eighteen years, is chief operator of the office. Mr. Chas. B. Fann, late dispatcher at Rock Island depot, this city, occupies the position of night manager. Miss Josie Guenther, late bookkeeper in this office, died recently at her home at LeMars, Iowa.

LONDON, ONT.—We have become domiciled in our new quarters in the Masonic Temple block, and the ruddy and happy faces of the operators and clerks prove that the change is highly appreciated. We are thankful to General Manager Dwight and Manager Furness for looking after our interests. They have provided us with a handsome, commodious and comfortable office, such as we have not hitherto enjoyed. The force here now consists of fifeeen operators; two check boys, ten messengers, two delivery clerks, three other clerks and two repairers. Since moving to our present offices, business has not increased as much as was expected, but we are preparing for a big rush this spring, and will be able to handle it in good style.

Miss McIntyre, one of the staff, was married this week to Mr. Donald Matheson, our representative at the G. W. Railway Station. The entire force assembled in the operating room the evening before the wedding and presented Miss McIntyre with a handsome watch and also an address, which was read by the veteran, Mr. Dave Adams. Miss McIntyre has been a member of the force for seven years and will long remember the pleasant associations of old "Dn."

TECUMSEH.

PORTLAND, ME.—Although it was expected that the Mutual Union office here would close on the 1st of this month, it is still open and doing a good business. The employés of the office now believe that it will be continued. There is strong talk among some of our largest and most enterprising merchants of building a telegraph line to Boston, to connect with the American Rapid or any other line that arrangements could be made with. Should the Mutual Union office be closed up, it is more than probable that such a line will be built during the coming summer. John F. Malone, one of the best operators in the Western Union office, is confined to his home with lung disease. Andrew E. Mathews, for some seven years a clerk in the Western Union office, and later an assistant in the Portland Signal office, is now connected with the book and stationery establishment of Hall L. Davis. Samuel T. Wood, a Western Union operator, formerly of the Portland office, but now at South Windham, was recently married to Miss Minnie Wiggen, an operator in the telephone exchange. They were the recipients of numerous wedding presents from their associates in the two offices. An effort will be made to have the new City Council take action toward the removal of telephone and telegraph poles from the streets, and compel the removal of electric light wires from the roofs of buildings, which will doubtless result in the running of wires underground. J. G.

BORN.

ROBSON—On Jan. 25, 1883, to Mr. H. E. Robson, Manager Western Union office, London, Eng., a son, still-born.

ROONEY—On. Feb. 25, 1883, to Mr. James M. Rooney, train dispatcher C. & N. W. Railway, Escanaba, Mich., a daughter.

MARRIED.

BOWES—WILLIAMS—At London, Eng., Feb. 10, 1883, Mr. E. C. Bowes, Western Union office, to Miss Annie Williams, of Swansea, South Wales.

ELECTRICAL PATENTS ISSUED.

Week ending Feb. 20, 1883.

Acoustic telephone; Oliver Higgins, Walter S. Higgins and Joseph Grim, Napoleon, O.	273,079
Electric call; Jacob B. Currier, Lowell, Mass.	272,862
Electric heat alarm: M. Martin, Malden, Mass.	272,893
Electric arc lamp; Elihu Thomson, New Britain, Conn.	272,920
Electric elevator; Schuyler S. Wheeler, New York, N. Y.	273,208
Electric mechanism for controlling the hands of clocks; John Happersberger, Cincinnati, O.	273,231
Indicator for fire alarm purposes; Moses G. Crane, Newton, Mass.	273,033
Lightning arrester for telegraph circuits; Josiah W. Dyer, Philadelphia, Pa.	272,867
Lightning arrester; John L. Finn, Elyria, O.	273,049
Lightning Conductor; Henry W. Spang, Reading, Pa.	273,179
Speaking trumpet for receiving telephones; Daniel Drawbaugh, Eberly's Mill, Pa.	272,866
Telephone transmitter; Daniel Drawbaugh, Eberly's Mill, Pa.	272,865

BUSINESS NOTICES.

Inspector of Police William Murray has lately had the Applegate Electric Alarm Matting put through his residence at 146 East Seventy-eighth street, and highly indorses it.

24-STOP ORGAN for $51.—The offer made in to-day's paper by Mayor Beatty, of Washington, New Jersey, of a 24-stop organ for $51, delivered at your very door, is one that lasts but 10 days from the date of this paper, and our readers should take advantage of it at once. The well-won reputation of this house assures buyers that they will get what he advertises; and the price, with all freight prepaid, should give him, as it will, thousands of additional satisfied customers. We are informed by good authority that Mr. Beatty is manufacturing and shipping sixty-nine organs daily, and is running his factory nights in order to fill orders promptly.

The attention of persons interested in local telegraph and telephone organizations is respectfully called to the electric lighting system of THE FULLER ELECTRICAL COMPANY, and the practicability of making arrangements with that company for the introduction of its apparatus, either in isolated plants or through the formation of local companies desiring to engage in the business of electric lighting. The specially valuable features of this company's system may be seen by examination of its apparatus in Boston, Worcester, Providence, New York City, Brooklyn, Jersey City, Paterson, Philadelphia, Hartford, Lancaster, Scranton, Syracuse, Rochester, Buffalo, Pittsburgh, Wheeling, Steubenville, Xenia, Dayton, Grand Rapids, Chicago, Springfield, Belleville, St. Louis, St. Paul, and many other smaller places throughout the country. Correspondence is invited. THE FULLER ELECTRICAL COMPANY,
44 East 14th street, New York City.

All Persons Sending for Catalogues or ordering articles advertised in our columns will do us and our Advertisers both a great favor by mentioning that they saw the advertisement in

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Davis & Rae's Electrical Diagrams and Connections. Oblong, 8vo., cloth, 32 full page illustrations; 2d edition, Price $2.00

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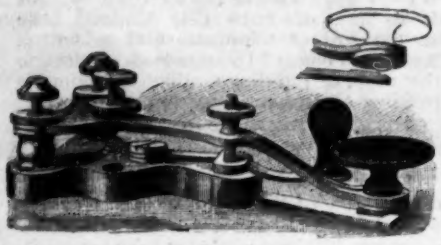

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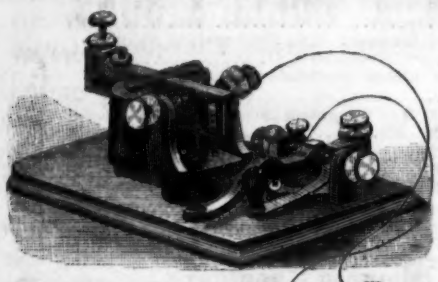

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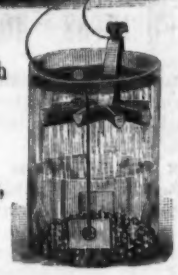

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NEW STYLE No. 1215. Height, 72 ins., Depth, 24 ins. Length, 49 ins., Weight, boxed, about 400 lbs.

Regular Price $85.00 Without Stool, Book and Music.

24 STOPS. 1 Cello, 8 ft. tone. 2 Melodia, 8 ft. tone. 3 Clarabella, 8 ft. tone. 4 Manual Sub-Bass 16 ft. tone. 5 Bourdon, 16 ft. tone. 6 Saxaphone, 8 ft. tone. 7 Viol di Gamba, 8 ft. tone. 8 Diapason, 8 ft. tone. 9 Viola Dolce, 4 ft. tone. 10 Grand Expressione, 8 ft. tone. 11 French Horn, 8 ft. tone. 12 Harp Æolian. 13 Vox Humana. 14 Echo, 8 ft. tone. 15 Dulciana, 8 ft. tone. 16 Clarionet, 8 ft. tone. 17 Voix Celeste, 8 ft. tone. 18 Violina, 4 ft. tone. 19 Vox Jubilante, 8 ft. tone. 20 Piccolo, 4 ft. tone. 21 Coupler Harmonique. 22 Orchestral Forte. 23 Grand Organ Knee Stop. 24 Right Organ Knee Stop.

☞ This Organ is a triumph of the organ-builders' art. IT IS VERY BEAUTIFUL IN APPEARANCE, BEING EXACTLY LIKE CUT. The Case is solid Walnut, profusely ornamented with hand-carving and expensive fancy veneers. The Music Pocket is of the most beautiful design extant. It is deserving of a place in the millionaire's parlor, and would ornament the boudoir of a princess.

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SPECIAL TEN-DAY OFFER. *If you will remit me $51 and the annexed Coupon within 10 days from the date hereof, I will box and ship you this Organ, with Organ Bench, Book, etc., exactly the same as I sell for $85. You should order immediately, and in no case later than 10 days. One year's test trial given and a full warrantee for Six years.*

Given under my Hand and Seal this 15th day of March, 1883.

Daniel F. Beatty.

COUPON On receipt of this Coupon and $51 in cash by Bank Draft, Post Office Money Order, Registered Letter, Express Prepaid, or by Check on your Bank, if forwarded within 10 days from date hereof, I hereby agree to accept this Coupon for $87, as part payment on my celebrated 24 Stop $85 Parlor Organ, with Bench, Book, etc., providing the cash balance of $51 accompanies this Coupon, and I will send you a receipted bill in full for $85 and box and ship you the Organ just as it is advertised, fully warranted for Six years. Money refunded with interest from date of remittance if not as represented after one year's use. (Signed) DANIEL F. BEATTY. **$87.**

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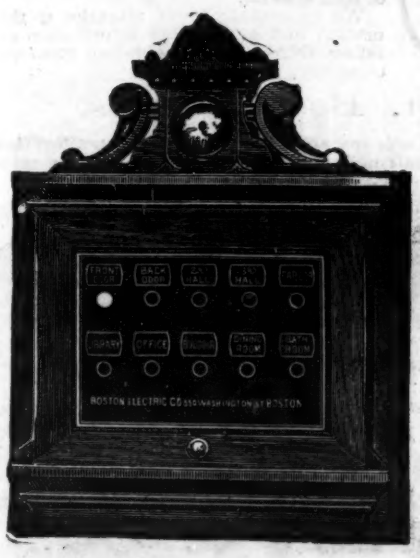

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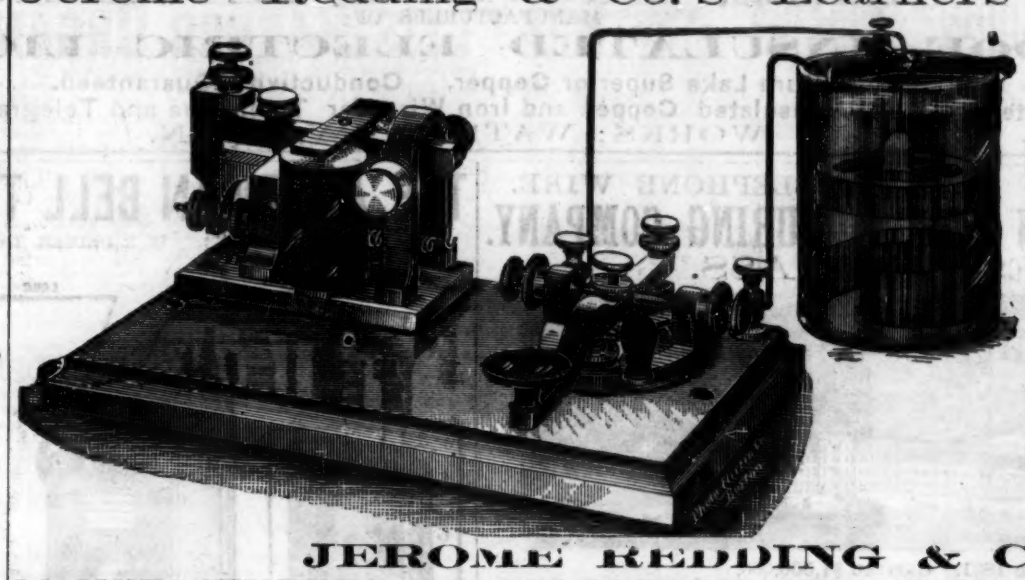

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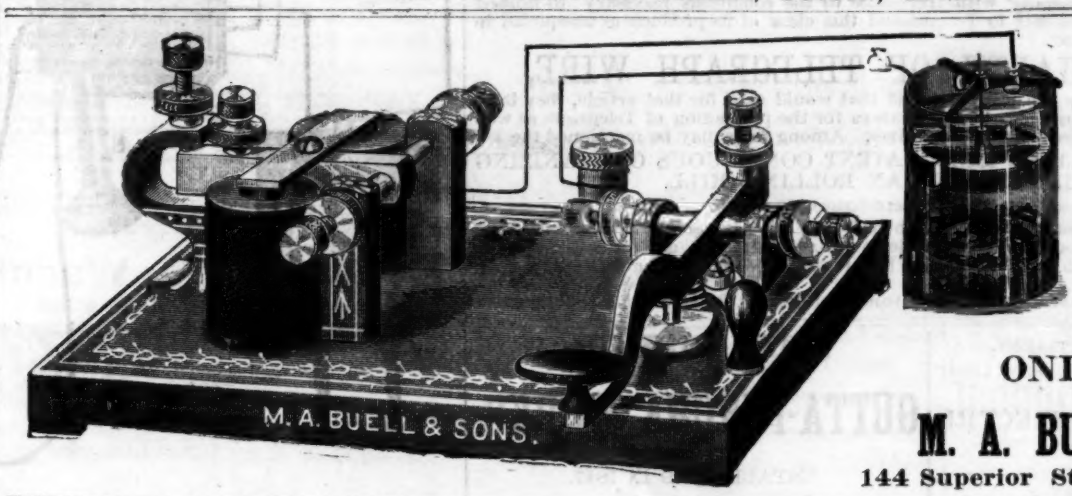

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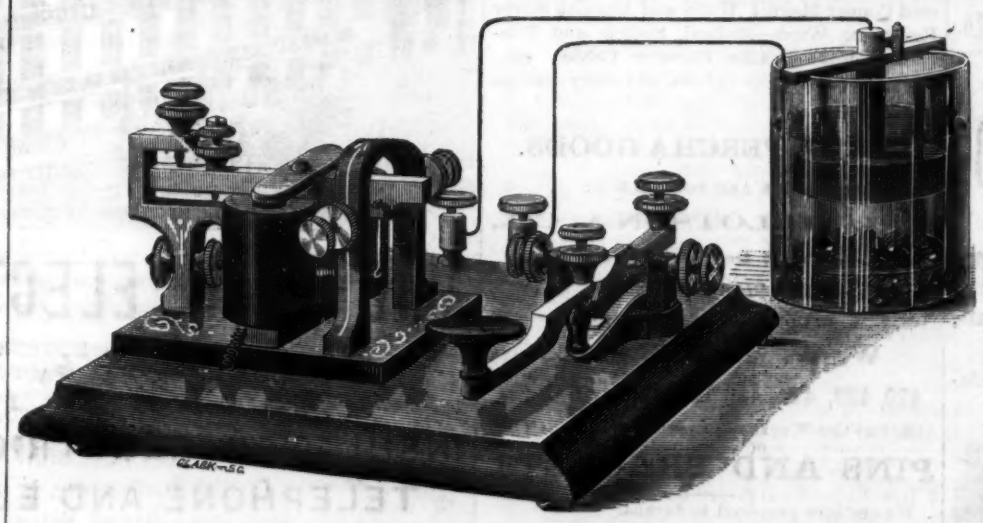

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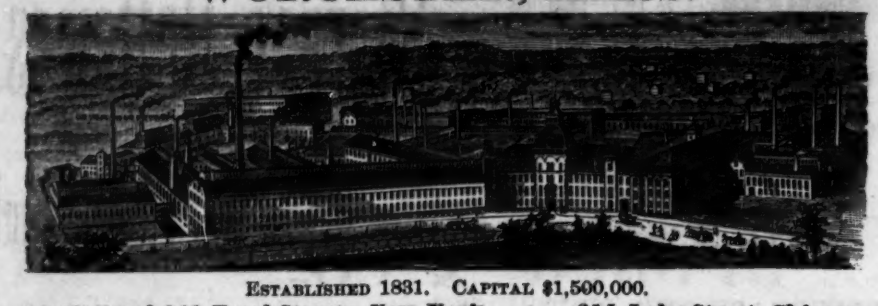

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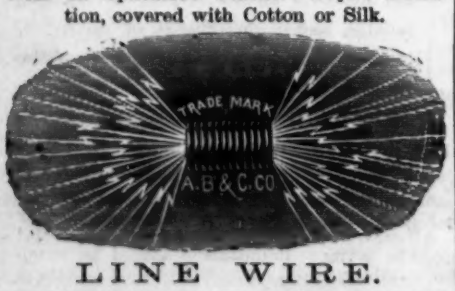

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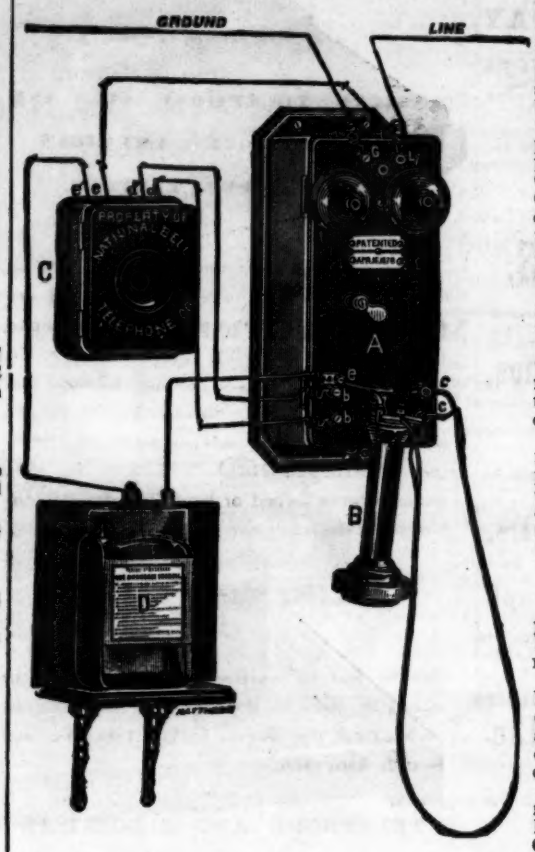

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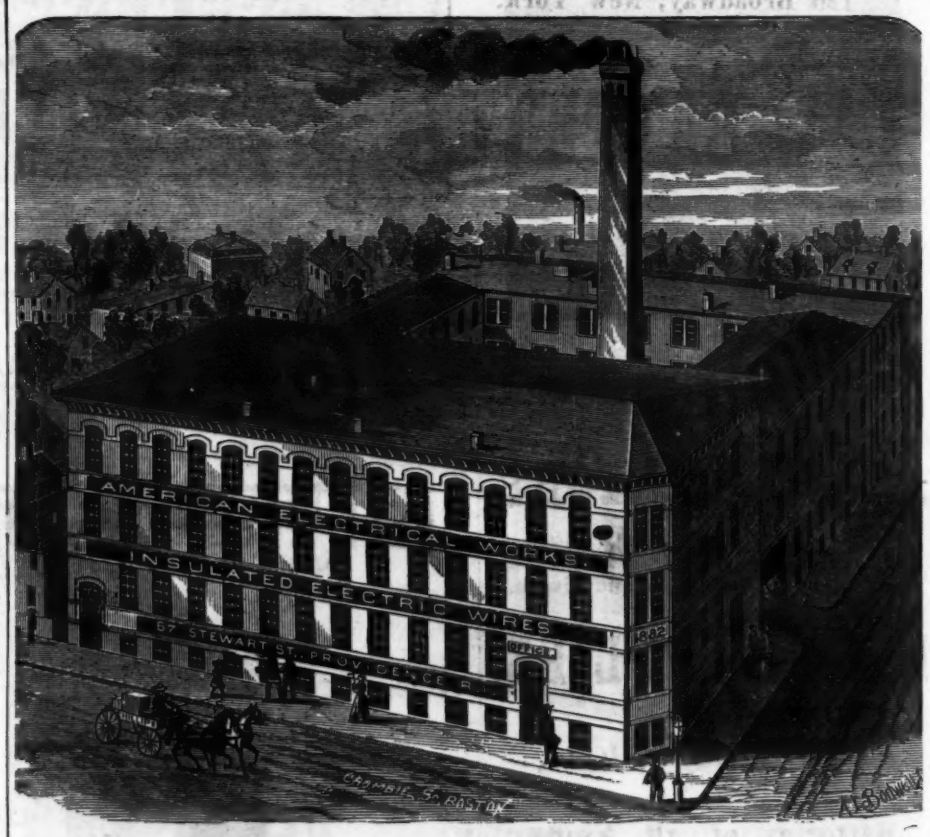

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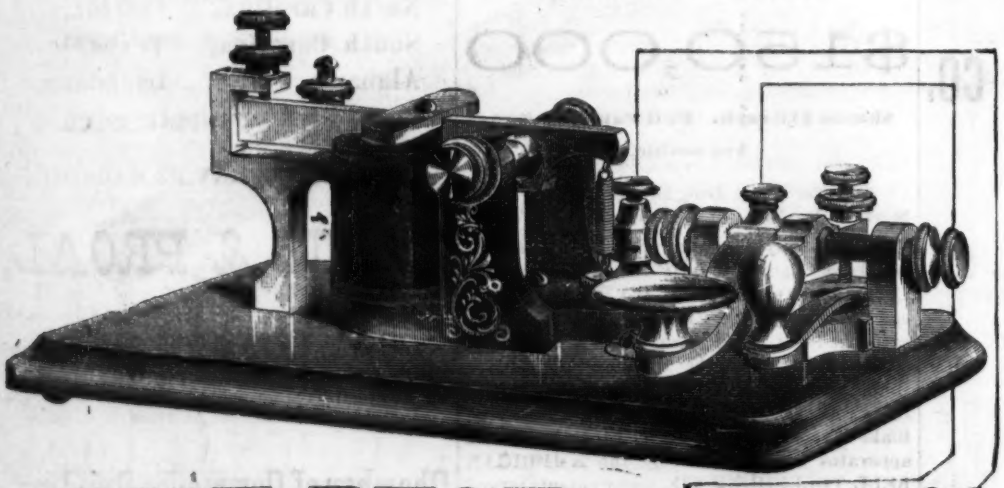

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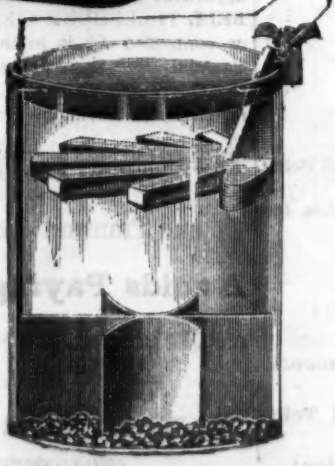

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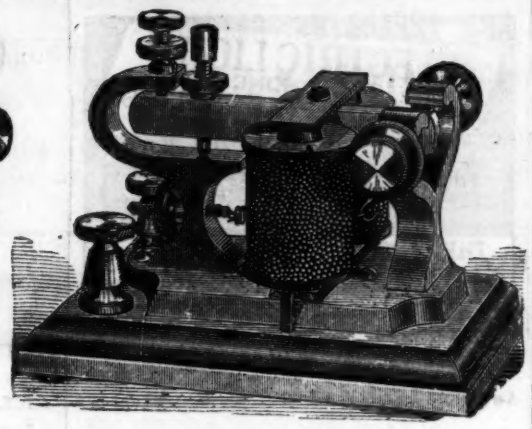

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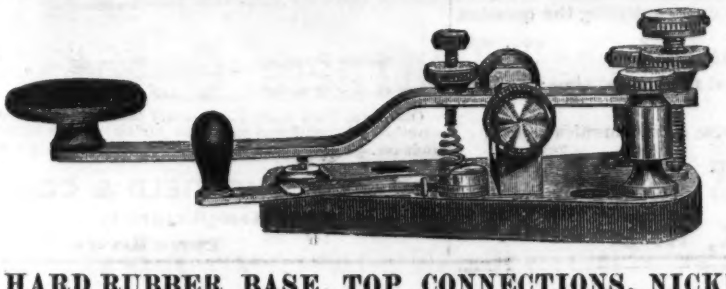

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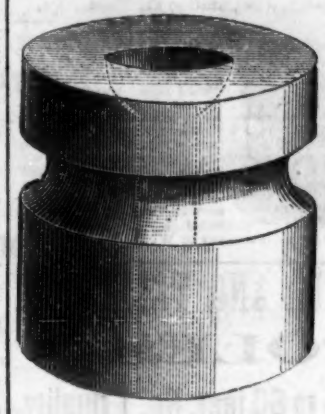

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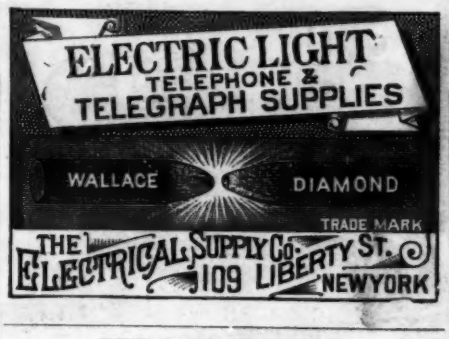

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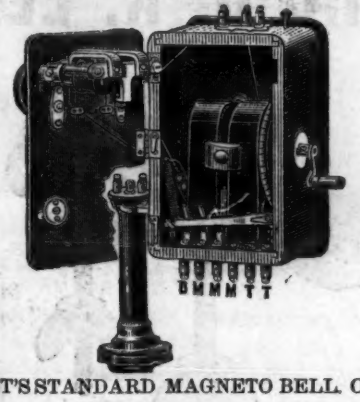
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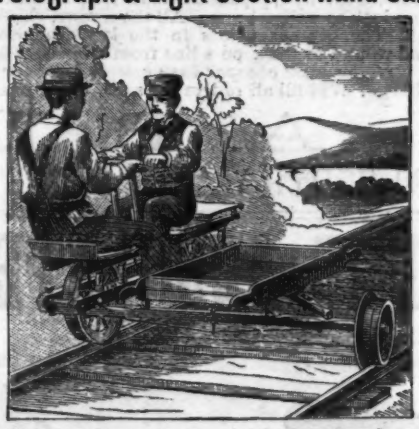
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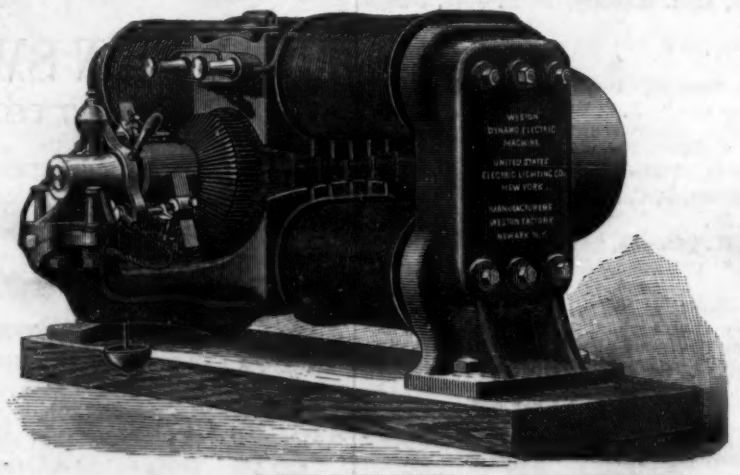

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